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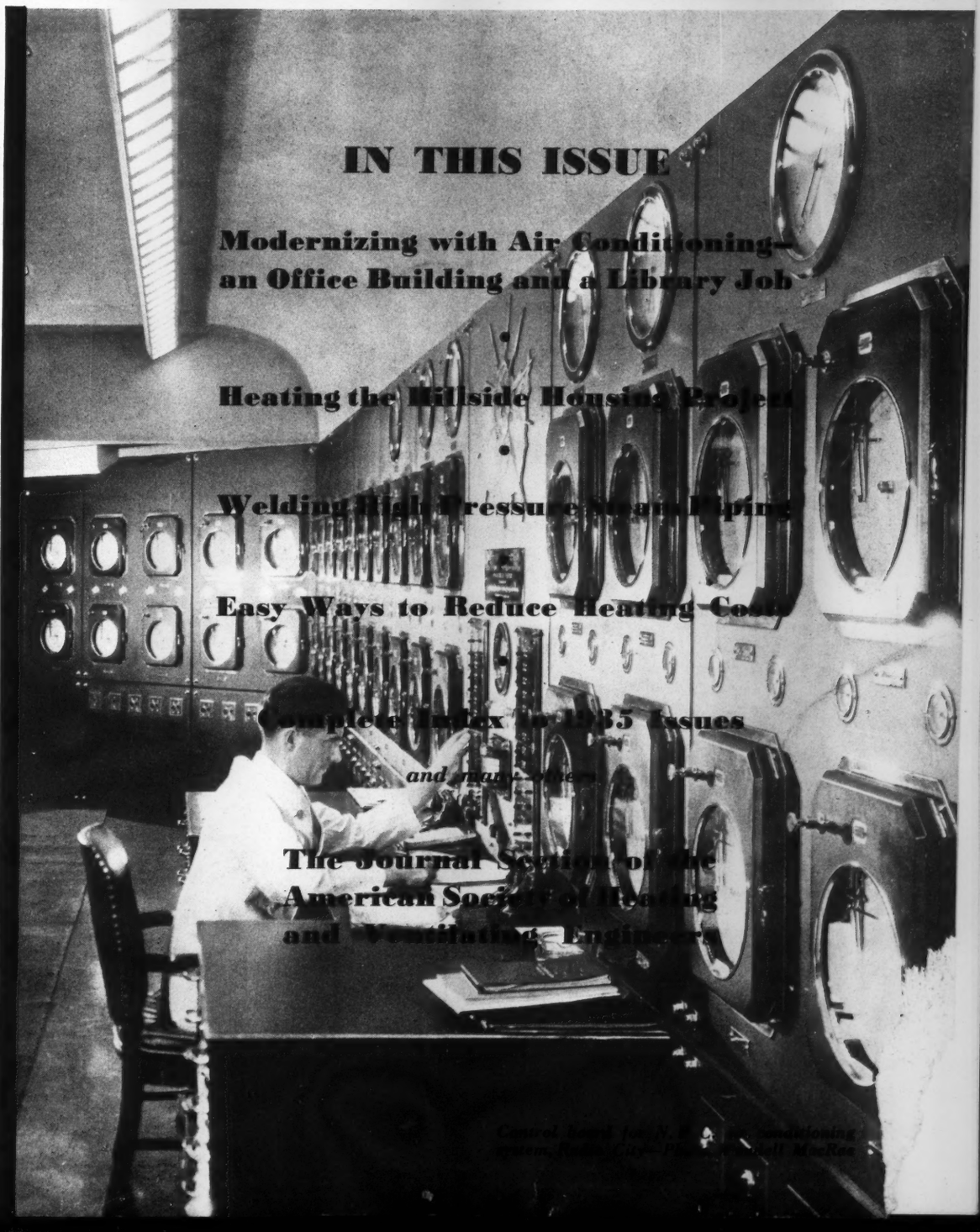
Table of Contents—page 29

DEC 9 - 1935

Heating · Piping and Air Conditioning



IN THIS ISSUE

Modernizing with Air Conditioning—an Office Building and a Library Job

•

Heating the Hillside Housing Project

•

Welding High Pressure Steam Piping

•

Easy Ways to Reduce Heating Cost

•

Complete Index to 1935 Issues

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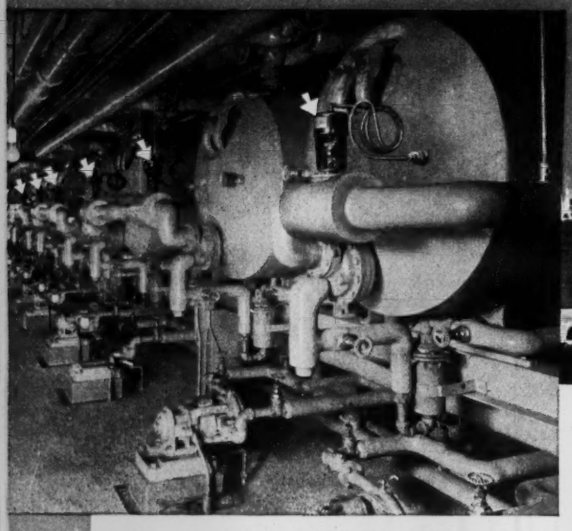

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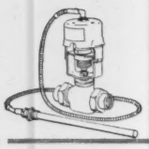

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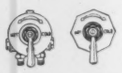

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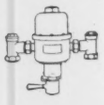

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THE EDITOR'S PAGE

A BIG SHOW, a big meeting, a big issue—all in January. Indications point to a highly successful Heating, Ventilating, and Air Conditioning Exposition at the International Amphitheater, Chicago, next month; demands of exhibitors for space have necessitated the opening of an additional exhibit wing. . . . The American Society of Heating and Ventilating Engineers has a particularly interesting and live program arranged for its annual meeting, which will be held during the same week, with headquarters at Chicago's Palmer House, and the National Warm Air Heating and Air Conditioning Association meets concurrently at the Stevens in Chicago. . . . The January issue of HEATING, PIPING AND AIR CONDITIONING will feature a complete directory of heating, piping and air conditioning equipment for industrial and large buildings; in addition it will include a special "show" section with full information about the Heating, Ventilating and Air Conditioning Exposition, an outstanding selection of articles, the regular Journal Section of the A.S.H.V.E.

Each December, HEATING, PIPING AND AIR CONDITIONING publishes its annual index; that for our 1935 issues appears this month—page 613, and following. . . . It is the key to a wealth of information on design, installation, operation and maintenance of heating, piping and air conditioning systems in plants and large buildings which has been published in these pages this year. . . . The index is in the form of brief descriptions of each article, similar to those compiled for previous volumes.

Our October cover illlustrated the Allegheny County Steam Heating Co.'s system operators' office, showed the instruments that enable better operation of Pittsburgh's steam heating distribution system. . . . This month's cover illustration is also devoted to instruments—these for operation of the extensive air conditioning systems for N.B.C.'s studios in New York. The board shown was designed by A. Warren Canney, who concludes his series on choosing the right air conditioning system this month. The photograph was taken by Wendell MacRae.

Air conditioning is involved in many modernization plans, and a number of such projects have been described in past months. In November, S. L. Rolland explained the indirect type of system installed in the Oklahoma Gas and Electric Co.'s main office building; this month, Terry Mitchell describes the direct expansion job for the National Reserve Life Insurance Co. building in Topeka—a job with a number of interesting features. An article describing modernization of an office building by means of a central station type of system is scheduled for next month. . . . Why air conditioning for profit *is* considered in so many modernization plans is indicated by the comments made by several of the National Reserve Life building's tenants. Here they are: Attorney—"The air is cool, clean and invigorating. The old end-of-the-day fagged-out feeling is gone. I am very enthusiastic about our air conditioned offices." . . . Stenographer—"Breathing the fresh, clean air enables me to do my work throughout the day in perfect comfort, and I leave the office at night feeling fine instead of being exhausted after a day's work." . . . Attorney—"One can utilize office space to greater extent in summer than would be possible were it not air conditioned. With the windows closed and all street noises shut out it is possible to concentrate on work in quiet and comfortable surroundings." . . . Dentist—"The temperature is ideal. All patients like it." . . . Office Manager—"It is marvelous. I notice our clerical workers accomplish a great deal more work than heretofore." . . . Physician—"I am tickled to death with it. You can come down here and work and go home without being a bit tired." . . . Attorney—"I find it just like going to the mountains, feels just like high altitude."

The problem of air conditioning buildings is not one for just a few of those who can afford it, according to Delmer R. Rippey of George & Co., Omaha, in a report to the Midwest and Northern Conference of Building Owners and Managers. It must be met and solved sooner or later by the owner or manager of the small building as well as the skyscraper and *the worse the financial condition of a building, the more reason for a definite effort to find the solution in order to prevent tenants moving to air conditioned buildings.*

Among the projects of the Stoker Manufacturers Association for the coming year, announced following the Association's annual meeting in Chicago last month, is the reviewing by its engineering committee of the Midwest Stoker Association's setting heights standards for steel boilers; setting heights for cast iron boilers, a new project, will also receive attention. . . . The Association voted to promote standardization of stoker sizes, both as to coal burning rates and capacities for steam and hot water radiation. . . . A campaign to promote passage of the Wagner Federal Public Housing Bill has been launched by the National Public Housing Conference, 112 E. 19th St., New York City. . . . The bill provides for the establishment of a slum clearance and low rent housing agency as part of the permanent governmental structure, is to be re-introduced by Senator Wagner early in January, it has been announced. . . . Unity in the approach to the problem of establishing adequate means for recognizing the engineer as a professional man is emphasized in the 1935 annual report of the Engineers' Council for Professional Development, 29 W. 39th St., New York City. . . . The Connecticut Board for the Registration of Professional Engineers and Land Surveyors announced recently that it is ready to receive requests for application blanks; the act creating the board was passed by the last legislature, is effective January 1. . . . A four page information circular explaining the rules and regulations for registration may be had upon request.

"Right up my alley" was the comment of one reader on Lyman R. Flook's description of the University of Chicago's steam conservation program—and the results it has achieved—published last month. . . . While referring specifically to cutting heating costs of a central steam system serving nearly eighty major buildings, the economy methods described by Mr. Flook apply as well to all types of plants and buildings. As the author pointed out, prompt, reliable records are half the job; the balance is largely personal and depends upon the enthusiasm of those actively in contact with the problem of efficient heating with economy.

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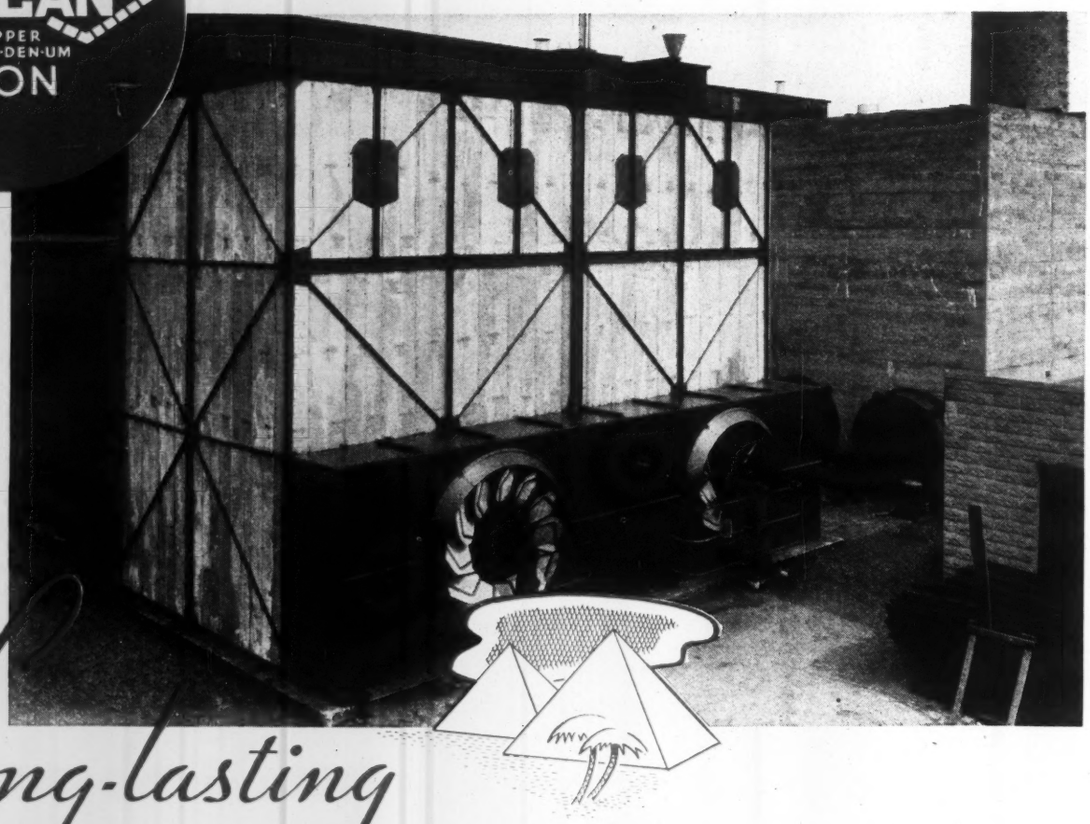

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CONTENTS *for* DECEMBER, 1935

Vol. 7, No. 12 Pp. 565-620

Air Conditioning Modernizes Library; Promotes Efficiency, Protects Books, by Ford J. Cumming 565

Welding High Pressure Steam Piping at U. S. Industrial Alcohol Co. Plant, by J. A. Freiday 568

Simple Changes in Heating Systems and Better Operation Reduce Steam Costs, by George H. Tuttle 570

Duct Design, Selection of Fan and Motor for Fume Exhaust Systems, by B. F. Postman 572

Handling Fuel Oil, by Kalman Steiner 575

Choosing the Right Air Conditioning System, by A. Warren Canney 577

Flow of Water in Piping Studied with Movie Camera; Results Described Here, by Edgar E. Ambrosius and John C. Reed 578

Modernizing with Air Conditioning, by Terry Mitchell 581

Heating the Hillside Housing Project, by H. G. Schaefer and Lewis Smith 583

Compact Piping Layout for Boiler Feed Pumps, by G. W. Hauck 586

Index to Volume 7, Nos. 1-12, January-December, 1935 613

Equipment Developments 620

Schools and Study Courses (back section) 94

Conventions and Expositions (back section) 94

Booklets, Reports and Papers (back section) 94

Book Reviews (back section) 96

Recent Trade Literature (back section) 98

Index to Advertisers (back section) 104

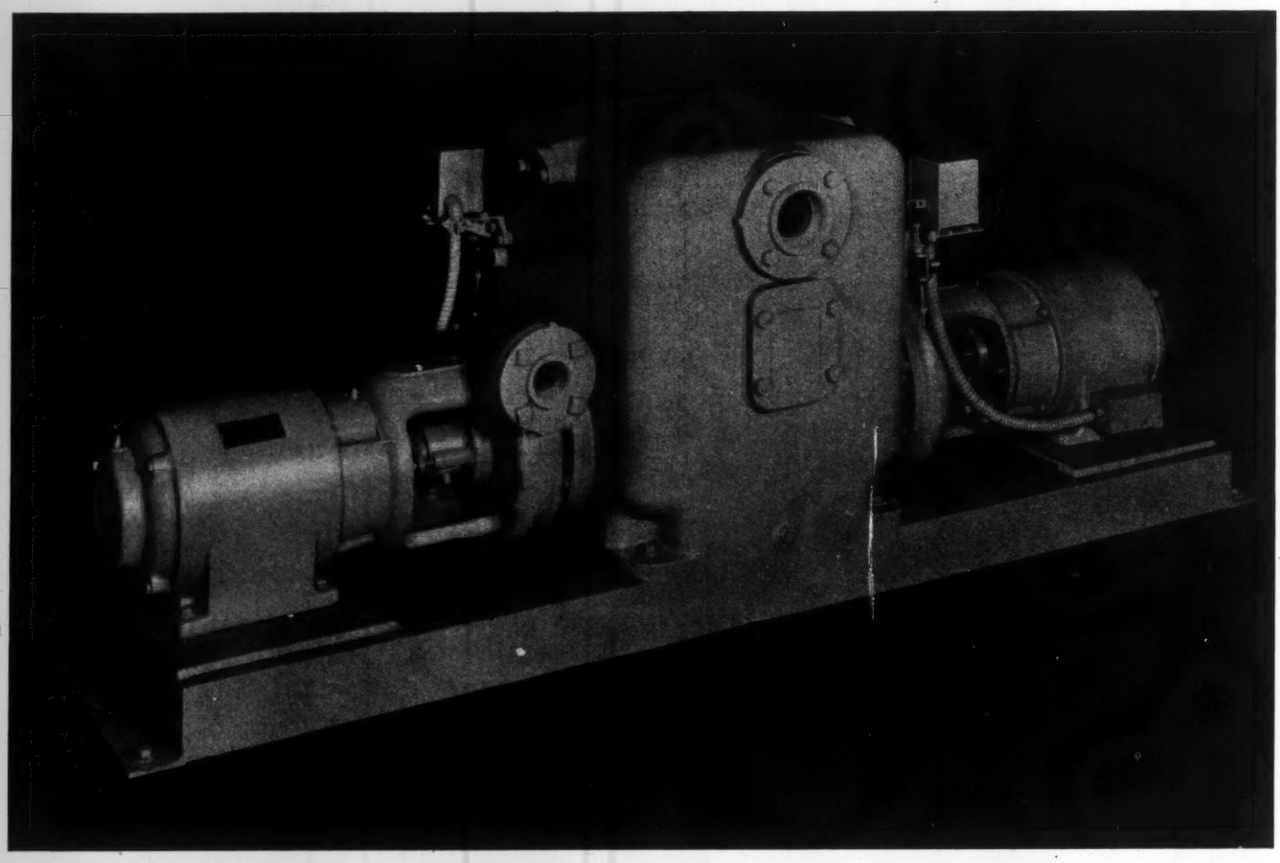
Journal Section of the American Society of Heating and Ventilating Engineers

Performance of Fin-Tube Units for Air Heating, Cooling and Dehumidifying, by G. L. Tuve 589

Fuel Saving Resulting from the Use of Storm Windows and Doors, by A. P. Kratz and S. Konzo 595

Bulletin Section 600

MAXIMUM EFFICIENCY FOR STEAM HEATING SYSTEMS ON HEATING, DRYING AND PROCESS WORK.



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Heating · Piping and Air Conditioning

Vol. 7, No. 12 • *December, 1935*

Air Conditioning Modernizes Library; Promotes Efficiency, Protects Books

By **Ford J. Cumming***

A YEAR 'round air conditioning system serving the entire building, including reading room and staff rooms, of the James J. Hill Reference Library, St. Paul, Minn., was put into operation July 1, 1935.

This building has a beautiful exterior and has an interior arrangement that is unique. The reading room is 150 ft long, 64 ft wide, and has a ceiling 51 ft high. The ceiling is a large skylight with indirect lighting which adds to the beauty of the room and also to the problem of air conditioning. The book stacks are on the side walls on the main floor. The second gallery has two story book stacks on the side walls, while the third gallery has a one story book stack extending around sides and ends. One end of the building is divided into twelve individual private study rooms, closed for quietness, and each room is air conditioned.

Filtered, washed, and tempered outdoor air is introduced to the main library room both summer and winter. The washer includes treatment with an alkaline solution for the removal of sulphur dioxide thus preventing deterioration of books and records.[1] Cooling is accomplished in summer by recirculating the air from the main library over coils through which artesian well water at a temperature of 52 F from a 10 in. diameter well 220 ft deep is circulated. Conditions maintained in winter are 72 F dry bulb and 40 per cent relative humidity, and during the summer the system will maintain 80 F dry bulb and 50 per cent relative humidity with outdoor conditions of 95 F dry bulb and 74 F wet bulb. A slight pressure is maintained within the building to prevent infiltration of untreated outdoor air.

A library air conditioning system serves a double purpose, promoting efficiency of the staff and those making use of its facilities, and protecting books and records, particularly through preventing deterioration caused by sulphur dioxide in the atmosphere.....How the James J. Hill Reference Library in St. Paul was equipped for year 'round air conditioning is described here; cooling is accomplished by means of 52 F water from a deep well; air is treated in the washer with an alkaline solution for removal of sulphur dioxide, and proper humidities are maintained summer and winter. The work was done without interfering with operation of the library and without impairing it architecturally

The Air Treating Units

The outdoor air treating unit, Fig. 2, located in the basement, consists of automatic oil filters, preheaters, cooling coils, washer, reheaters and 5100 cfm fan. For summer operation a controlled amount of outdoor air is introduced into this system where it is first filtered and then precooled. Next this air passes through the alkaline solution spray in the washer. The air, after passing through the reheat coils is introduced to the three story main library room through two floor grilles near the front of the room.

The main cooling load is carried by two separate cooling, dehumidifying, and recirculating units in the attic space directly above the main library room. The larger of these units recirculates and treats the air in the main library or auditorium room. The smaller recirculates the air in twelve study rooms, librarian's office, and four catalog and work rooms. Air from the main library is picked up through a series of ducts and grilles in the three balconies ranging along both sides of the main auditorium. These return ducts are connected to each of these cooling units. Each of these units consists of an automatic oil filter, cooling and dehumidifying coils and a fan. Control of the air temperature delivered from these units is by means of a bypass. The treated air from the larger unit is delivered into the main library or auditorium through high velocity grilles,

*President, Beecher-Cumming, Inc. Minneapolis, Minn.

[1]For information on preventing damage to books and records from sulphur dioxide by means of air conditioning see "Air Conditioning of Libraries," p. 302, July, 1934, issue of HEATING, PIPING AND AIR CONDITIONING, which reviews the work of the National Bureau of Standards on this subject.

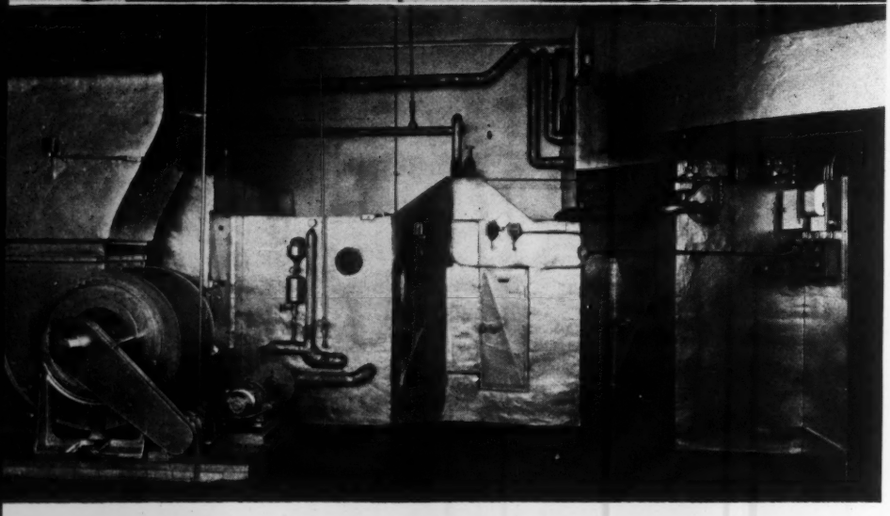
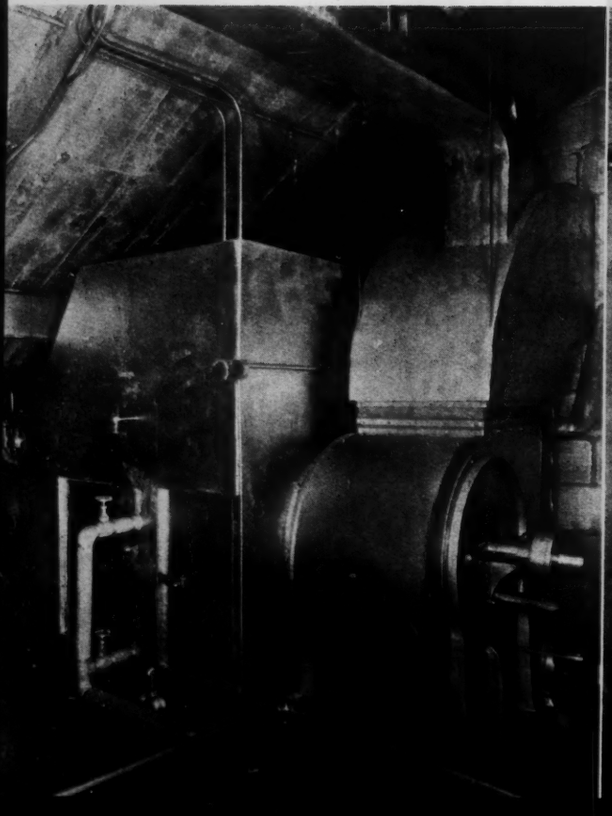


Fig. 1 (*above*)—Main library reading room of the James J. Hill Reference Library, St. Paul, which is air conditioned summer and winter, cooling being furnished by water from a deep well. The air is treated with an alkaline solution to protect against damage from sulphur dioxide. . . . Fig. 2 (*below*)—Outdoor air treatment plant in the basement comprising preheaters, filters, cooling coil, air washer, reheat coil, fan and control

properly spaced on the supply ducts which run longitudinally on each side of the auditorium at the third floor level. The quantity of air to each grille is controlled by a splitter damper.

The second and smaller cooling and dehumidifying unit, Fig. 4, is similar in design to the one serving the main library or auditorium. The air is discharged from it into a duct running along the attic space horizontally to the rear of the building where it is split up and dropped vertically down the back wall to the twelve study rooms. Air is introduced into each study room through high velocity grilles and is exhausted into the main library room through door louvers. A second duct leads to the librarian's office and workrooms, discharging through high velocity grilles; air returns through door louvers into main library room.

The intake side of this second unit is, as was stated, connected through the main series of ducts and return grilles to the main auditorium, thus permitting complete recirculation of all the air in the library.



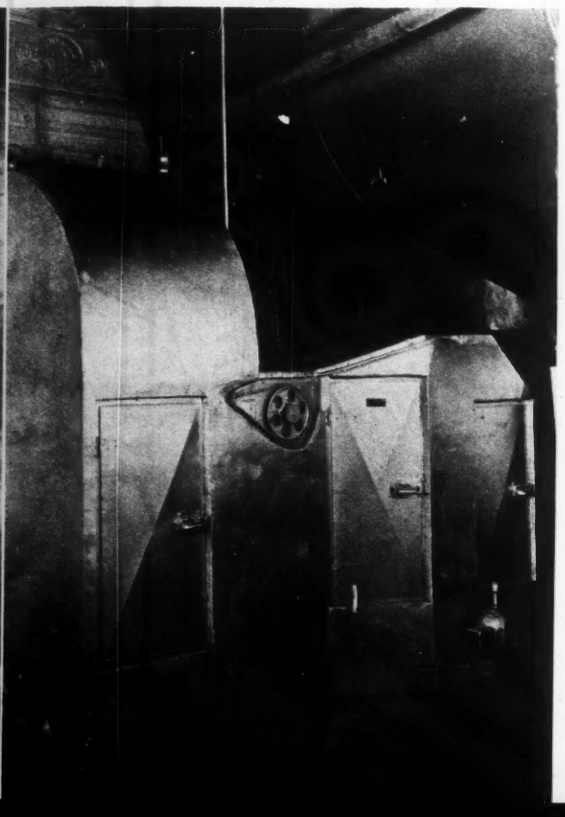


Fig. 3 (*left*)—One of the two recirculating units in the attic space which handle the actual cooling load. This one serves the main library room or auditorium; the fan has a capacity of 14,000 cfm. . . . Fig. 4 (*right*)—The second recirculating cooling and dehumidifying unit, similar to that shown in Fig. 3 but with a 4200 cfm fan, serves offices, study and rest rooms along the back of the auditorium on the three balconies

Temperature and Humidity Control

Control of humidity is through the outdoor air unit in the basement and consists of a humidistat located in the main library room which controls a modulating motor operating a face and bypass damper on the preheating coil. A duct thermostat on the room side of the reheaters maintains a minimum temperature of 80 F the year around by controlling a face and bypass damper on the reheating coils. A second duct thermostat between the preheater and the washer automatically shuts off the fan and fresh air intake in the event of failure of the preheater coil.

Automatic control for the two attic units consists of a duct thermostat on the intake side of the recirculating duct maintaining a minimum temperature and humidity by means of a modulating motor operating bypass dampers. The well pump is controlled by a thermostat which is set to cut the pump in and out at predetermined temperatures.

The complete installation is insulated with 1 in. of cork, plastered and painted, with the exception of duct work extending through actual conditioned spaces. Condensation from the two attic cooling units is taken care of by means of condensate pans constructed of 32 oz. copper and equipped with automatic float valves which shut off the pump in case of drain failure, thus eliminating any chance of flooding the auditorium ceiling. Existing ducts were used wherever possible.

Cold Water Circulation

The deep well terminates in a specially constructed room outside the building but easily reached through a stairway from the back entrance enclosure of the building. The well was driven to a point providing 300 gpm of water. The deep well turbine type pump, driven by a 220 volt, 60 cycle, 3 phase, 10 hp motor has a capacity of 100 gpm against a head of 220 ft. The motor is controlled by a hand switch in the basement. In addition, the duct thermostat mentioned above starts the pump at 81 F and stops it at 78 F. The pump is not equipped with any valves, the system being designed so that when the pump stops, all water in the system drains back to the well—a safety measure. The water is distributed to the cooling coils through copper piping with anti-sweat covering, and the coils themselves are of finned copper tubing brazed into copper headers and tested to 300 lb pressure.

Heating and Humidifying

During the summer operation, the reheat coil is supplied when necessary with *hot water* from a stoker fired boiler which also supplies domestic service water to the building. During winter operation, this coil is supplied with *steam* from the main heating plant boiler, also stoker fired. This new air conditioning plant enabled the removal of eight radiators formerly located in the center of the main library room, increasing floor space and improving appearances.

The three units of this installation present a fine appearance and are strategically located to give the greatest opportunity for observation of the workings of the system itself, for the convenience of such of the public as may be interested, as well as the engineer in charge of operations.

The system was designed by the author and his associate, L. S. Houston. The installation work was all done at night or other hours when the library was closed, and the operation of the library was uninterrupted. The equipment was so installed as to be entirely unseen; the beauty of the library—and it is very beautiful—was in no way impaired. The general contractors were Beecher-Cumming, Inc. The duct work was done by Conditionaire, Inc., the deep well driven by Keys Well Drilling Co., and the piping installed by Hineline Co.

The author acknowledges his appreciation of the splendid cooperation received from W. O. Washburn, chairman of the library building committee, Miss Helen Starr, librarian, and the library staff.

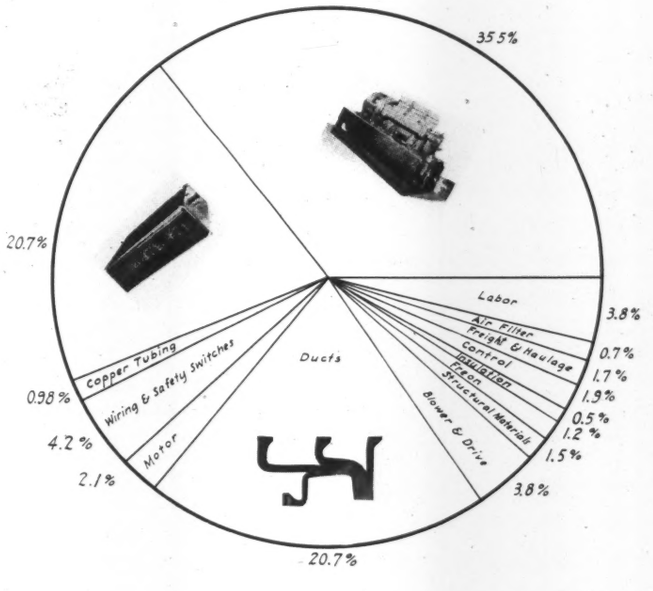


Chart Shows Cost Break-Down for Air Conditioning Installation

THE chart reproduced here[1] is based upon the average installed cost of a system involving complete air conditioning in a building already having a steam supply available. The air conditioning system considered was composed of either a factory built or fabricated unit having a fan, steam heating coils, direct expansion "Freon" cooling coils, spray type humidifier, and dry type filters. This unit supplied air to the conditioned space through a relatively short duct system which was treated architecturally to harmonize with the building details. The figures represent an approximate average cost on a number of jobs, sizes from approximately 6 tons minimum to 40 tons maximum.

[1]Developed by Westinghouse Electric and Mfg. Co.

Welding High Pressure Steam Piping at U. S. Industrial Alcohol Co. Plant

By J. A. Freiday*

Welding of the process and power steam piping involved in a recent plant reconstruction project is described. The work included an 8,400 ft, 12¾ in. O. D. ⅜ in. wall lap welded steel line, and 14 in. O. D. 11/16 in. wall thickness seamless tubing . . . . Qualification of the welders, the welding, stress relieving, and testing the piping are among the topics covered

ABOUT a year ago the U. S. Industrial Alcohol Co. decided to recondition its Baltimore plants; the work involved reconstruction of many old buildings, new construction and a complete new generating system to supply steam for process, power and heating. Layout of the plants is unusual in that they are about ½ mile apart "as the crow flies," the U. S. Industrial Alcohol Co. plant being located in Curtis Bay while that of the U. S. Industrial Chemical Co., a subsidiary, is at Fairfield, ½ mile distant across the bay; the distance by land is over 1½ miles. Each of these units had their own steam generating plants operating at 150 lb per sq in. which were sorely in need of repair. It was imperative that a new system be provided to replace the old and to care for future expansion.

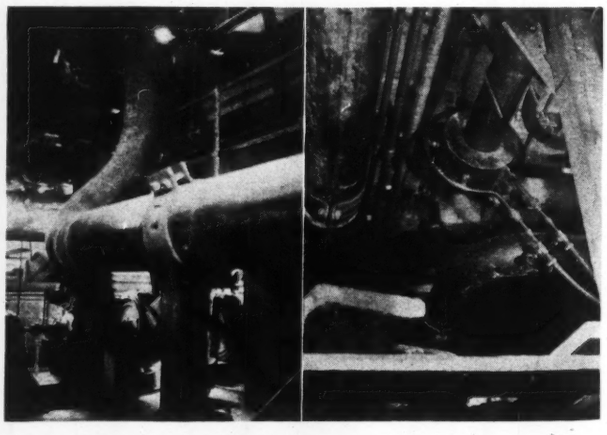
After careful analysis of many methods it was decided to build a high pressure, high temperature system at the alcohol plant in Curtis Bay. The steam is first run through back pressure turbines to generate electric power for plant use, and then taken from the turbine exhausts at 150 lb and 100 F superheat for process and other uses in both plants. The final design comprehends generation at 625 lb and 750 F total temperature. An excess of the 625 lb, 750 F steam is provided over that required for turbine operation, which is taken to a pressure reducing station and reduced to the plant medium pressure—150 lb and 100 F superheat. These pressures and temperatures are not high in the light of modern central station practice but they are relatively new in the field of industrial plant operation. All piping in these various systems from 2 in. standard weight to 14 in. O.D. 11/16-in. wall Grade A seamless tubing has been oxy-acetylene welded.

This work was started early in the fall of 1934, about the time peak production on anti-freeze alcohol was beginning. It was necessary therefore that it be carried forward with minimum interference to plant operations. It was decided to recondition the old boilers at the chemical plant and use them during the construction of the new high pressure plant and later as standbys. In making room for the new boilers at the alcohol plant, it was necessary to dismantle six boilers, half of the capacity. To supply the steam required at the chemical plant, a 12 in. steam line was run between the two plants.

Erecting 8,400 Ft, 12¾ In. Line

This steam line, while nothing extraordinary in diameter or length for a welded pipe line, is something of a record in other respects. It consists of 8,400 ft of 12¾ in. O.D. ⅜ in. wall lap welded steel pipe. More than 2,000 ft of this pipe was erected and welded in steel structures 30 to 60 ft in the air. The line traverses filled marshes, crosses state highways, city streets and a large railroad freight yard. Where the line runs near the ground it is supported by pipe hangers on wood piles driven in the ground. The problem of drainage of this line was complicated by the fact that for the first several months of its operation the line would carry steam in one direction and later in the opposite direction. This same condition would exist if it were necessary to shut down the high pressure boilers at the alcohol plant and use the standby capacity at the chemical plant.

Work on the line started about October 1 and steam was in the line about the middle of November. Welding was accomplished by a process employing back-hand technique. Each welding operator was required to make a position weld on 12¾ in. O.D. ⅜ in. wall pipe. From this sample, eight test coupons were removed; two from the top, four from the sides, and two from the bottom. Two of these coupons were tested in tension, two by the free bend method, two by the reverse bend method



***Left*—14 in. O.D. ⅜ in. wall medium pressure line with double offset bend. Clamp in foreground was used for lining up. . . . *Right*—The circular device with circular connecting pipes is a portable stress relieving furnace burning liquefied petroleum gas and compressed air; 6 in. high pressure line weld being stress relieved**

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From a paper read at the annual convention of the *International Acetylene Association*, Cleveland, Ohio, November, 1935.

and two were given the nickbreak test. Four operators were tested and qualified, two of whom worked for but a few weeks in the early stages; most of the welding was accomplished with two operators. Daily weld production averaged 10 to 12 per 8 hr day where the line runs near the ground; a few "high days" showed 15 and 16 welds. In the elevated structure production fell to 7 to 10 welds per day due principally to extreme cold weather and high winds; the difficulty of working in the steel work probably contributed to the lowered production. These figures include the so-called rolling and position welds and, further, each operator lined up and tacked his own joints.

Before tying-in, the line was blown down several times with live steam to remove scale, dirt and foreign substances. In performing this operation on one section, the steam was fed too fast with the result that the water pocketed momentarily, subjecting the line to severe shocks. The action was very close to that of a water hammer but fortunately did not reach that magnitude. The line could be distinctly seen to whip and sway. At one of the vertical expansion loops the pipe was lifted off the roller supports and crashed down again with sufficient force to shear off a 2 in. shaft on the cast steel roller and crack the base. Through all this, no failures developed in the pipe or welds. When the line was completed it was subjected to a test at full steam pressure. The idea of hydrostatically testing the line was abandoned due to the cost of filling a pipe of this size and length with water and also because of the extremely cold weather. The finished line containing 496—12 in. line welds, 16—6 in. tee or nozzle welds, and numerous smaller welds, developed no leaks or failures under full steam pressure test, and after a year's operation is giving thoroughly satisfactory service.

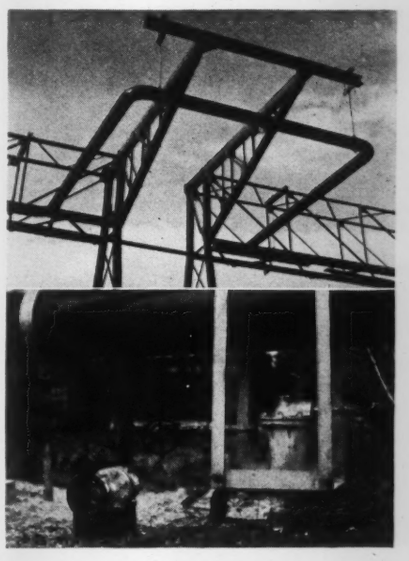
The line is covered with 3 in. of 85 per cent magnesia insulation and joints cemented with asbestos cement. The outside weather protection consists of heavy tarred building paper with 4 in. lapped joints carefully cemented in place and also held with copper wire banding every 4 in.

With this line completed, tying in the chemical and alcohol power plants, work was started on demolishing six of the old boilers at the latter plant. In their place were erected two 1,007 hp pin tube, water wall, bent tube boilers equipped for either powdered coal or oil firing.

Welding Piping for the Power Plant Installation

The power and other piping for the power plant installation was designed in accordance with the *American Standards Association* Code for Pressure Piping, the American Tentative Standard of which has just been published.[1] Since this code was not generally available the specifications for this work were necessarily very detailed. The welding specifications for this piping followed the Code closely. One deviation merits mention here and involved the substitution of one test weld for the two required in the Code. Since 14 in. O.D. Grade A seamless tubing $\frac{11}{16}$-in. wall thickness was the largest size to be used and further, since much of this pipe would be position welded, it was decided to make the qualification test weld a horizontal position pipe weld on this large size. A total of five welding operators were qualified on this test.

Multipass welding was employed on all the high pressure piping while single pass welding was used on the medium pressure piping. The use of multipass welding on heavy wall pipe insures better quality welding. All welds in the high pressure piping 4 in. in diameter and



***Above*—Expansion loop made up of welding elbows and straight lengths carried on overhead steel structure. . . . *Below*—Steam trap and 2 in. free blow valve on 8,400 ft outdoor line. Note method of supporting trap so as not to strain drip connections when line expands and contracts (Photos, Air Reduction Sales Co.)**

larger were stress relieved by heating to 1450 F and holding at this temperature in the ratio of 1 hr per in. of thickness.

Much of the piping was fabricated into convenient shipping lengths at the piping fabricator's plant, and all welds in such prefabricated piping were stress relieved at the shop. As a consequence of this procedure, practically all field welds were position (both horizontal and vertical) welds and naturally progress was slow. All field welds in high pressure piping were stress relieved with portable furnaces using liquefied petroleum fuel gas and compressed air, which proved very satisfactory for this work.

The entire power piping system was tested hydrostatically, the specifications calling for 1½ times normal working pressure. The high pressure piping was tested at about 1,075 lb per sq in., which was about 100 lb per sq in. above the required test pressure of 975 lb (1½ times 650 lb per sq in.). Under this pressure, each weld was hammered hard with a 5 lb hammer and no leaks or failures were discovered. The medium pressure piping was tested at 225 lb per sq in. (1½ times 150 lb per sq in.) and no leaks or failures discovered. The fact that under test and during 4½ months of operation no leaks or failures have developed speaks well for the welding done.

The design, supervision and inspection of the project was carried on by Thos. E. Murray, Inc.

[1] This Code was reviewed in detail by Sabin Crocker in a series of articles published during 1934 in Heating, Piping and Air Conditioning, and was approved as an American Tentative Standard June, 1935.—ED.

Simple Changes in Heating Systems and Better Operation Reduce Steam Costs

By George H. Tuttle*

After advantage is taken of the "everyday opportunities" for reducing plant and building heating steam consumption, there remain often over-looked but simple improvements which contribute to economy in operation.....Actual examples, based on meter readings before and after, are cited here

WHY should two buildings—to all outward appearances of the same construction and with mechanical equipment of the same caliber—vary as much as 25 per cent in the amount of steam required for heating?

The question is of interest to those who have apparently kept their heating systems in good repair but who still believe that there is something that may be done to reduce operating costs further. The answer is indicated by the examples of improved maintenance discussed here.[1]

Let us assume at the start that advantage has been taken of most of the "everyday opportunities" for reducing heating costs, such as repairing thermostatic traps, covering steam piping, removing obstructions which would prevent the free flow of air to and from radiators, having the heating system properly vented and trapped so as not to impede the circulation of steam, and so on. After these routine repairs have been made, there are often possible improvements which are over-looked.

Case 1—Separate Steam Line Installed for Heating a Restaurant

Table 1 shows the steam consumption for an office building in which a restaurant is located; the restaurant requires steam for heating for much longer hours than the remainder of the building, and during the year previous to the alteration it was necessary to supply steam to the entire building in order to satisfy the restaurant heating requirements. During the summer between the two years shown a separate line was installed for heating the restaurant. The resulting saving, calculated on a degree day basis, varied from 18 to 73 per cent.

Case 2—Separate Line Installed to Supply Steam for Water Storage Tank

Table 2 shows the monthly saving made by installation of a separate steam line to the heater of a water storage tank on the roof of a loft type building. During the first year shown in the table, the storage tank water heater was connected to the building heating system, and it was necessary to supply steam to the entire system for more hours than were necessary for heating the building.

During November of the second year shown, the new line to the heater was put in. For the remainder of the year the consumption per degree day was less each month than for the corresponding month of the previous year, the percentage decrease ranging from 1.8 to 25.9. Installation of the new main cost slightly over $100; the saving the first year was several times that.

Case 3—Effect of Intensive Study of Operating Conditions and Automatic Temperature Control

The first two examples illustrate savings made possible by installation of a separate main for the parts of the building which require long-hour use of steam. Table 3 shows what can be done by properly controlling the use of steam, and the possibilities of thermostatic control.

This table refers to an office building requiring comfortable temperatures from 8:00 a.m. until 5:00 or 6:00 p.m. During the first season shown, operation of the heating system was quite careless and control was entirely manual. The janitor had two other buildings to care for, and as this building was served with district steam, he felt that it would take care of itself. During the summer, after the first season shown in Table 3, it was brought to the attention of the owner that if the operation of the heating system could be watched more closely, a saving in steam consumption could be effected. As a result, he detailed more of the janitor's time to this building the following year; monthly savings resulted which ranged from 3.3 to 29.9 per cent. During the summer between the second and third seasons shown, the owner was told that he could further reduce steam consumption and also relieve the duties of the janitor by installing a thermostatic control, and this advice was followed. An inside central thermostat with clock control, permitting a lower inside temperature over night, was installed in November.

The first month of operation was not entirely satisfactory as far as savings were concerned because too high a night temperature was maintained; a new element was therefore installed in the thermostat allowing the night temperature to be maintained at 50 F rather than 60 F. After this change, the monthly saving over the previous year varied from 11 to 28 per cent. Had the thermostat been in operation the second year, the probable saving as shown in the table would have varied from 18 to 47 per cent.

*Engineer, Central Heating Department, The Detroit Edison Co., Detroit, Mich.

[1]Information for the examples given here has been taken from records of buildings served by a district heating company; the same economies are possible if the building is supplied with steam from an individual boiler. Metered results of buildings served from a district heating company, however, lend themselves more readily to comparison.

In each example the metered steam consumption is shown by months. Where the examples point out savings which have been made due to improvements to the heating system, the savings are calculated on a degree day basis. In the one example of a domestic hot water system the saving is calculated on a steam consumption per day basis. In all cases, consecutive seasons are shown, one before the improvement was made and another the year following. In the tables, the metered steam consumptions are shown in pounds per month. In some cases, where the meters were not read on the same date each month, the months may include a few days more or less than the calendar month.

Table 1—Steam Savings from Installation of Separate Steam Line to a Restaurant

	Year Previous		Year Following		
Month	Steam Consumption	Consumption Per Degree Day	Steam Consumption	Consumption Per Degree Day	Per Cent Saving Over Previous Year
Oct.	65,700	438	14,200	118	73.0
Nov.	174,500	332	97,000	216	35.0
Dec.	279,100	257	143,000	140	45.6
Jan.	284,700	271	171,400	154	43.2
Feb.	254,700	236	212,900	177	25.0
Mar.	251,600	246	264,700	200	18.7
Apr.	207,600	275	164,300	177	35.7
May	160,600	346	63,300	137	60.4

Table 2—Savings Effected by Installation of Separate Steam Line to Water Storage Tank

	Year Previous		Year Following		
Month	Steam Consumption	Consumption Per Degree Day	Steam Consumption	Consumption Per Degree Day	Per Cent Saving Over Previous Year
Oct.	50,310	419	19,045	634	
Nov.	276,705	486	257,660	505	
Dec.	481,325	501	362,635	433	13.6
Jan.	603,005	543	576,225	533	1.8
Feb.	733,070	611	650,650	534	12.6
Mar.	818,935	673	542,425	499	25.9
Apr.	572,260	577	340,730	455	21.2
May	269,100	583	246,025	438	24.9

Table 3—Saving Effected by Rigid Utilization Habits and Installation of Thermostatic Control

	Wasteful Operation		Careful Operation		
Month	Steam Consumption	Consumption Per Degree Day	Steam Consumption	Consumption Per Degree Day	Per Cent Saving Over Previous Year
Oct.	28,500	211	9,700	80.8	61.7
Nov.	102,400	207	90,800	159	23.2
Dec.	188,800	184	147,000	153	16.8
Jan.	209,100	204	158,800	143	29.9
Feb.	191,400	196	192,100	160	18.4
Mar.	208,100	208	198,300	163	21.6
Apr.	158,700	182	144,400	145	20.3
May	71,300	153	68,400	148	3.3

	Automatic Control Operation			
Month	Steam Consumption	Consumption Per Degree Day	Per Cent Saving Over Previous Year	Two Year Saving, Per Cent
Oct.	4,700	84		
Nov.	86,700	170		
Dec.	152,800	182		
Jan.	136,600	127	11.2	37.8
Feb.	144,900	115	28.1	41.3
Mar.	131,200	121	25.8	41.8
Apr.	82,600	110	24.1	39.5
May	70,100	125	15.5	18.3

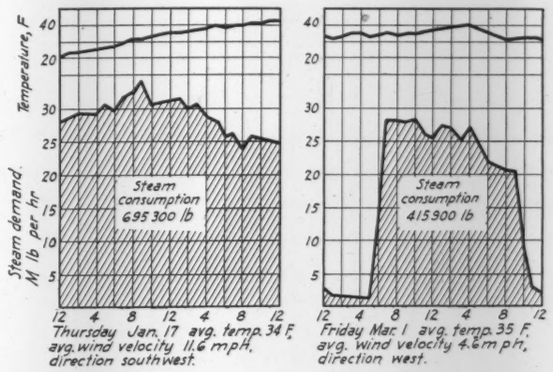
Table 4—Net Saving from Weatherstripping Windows, Caulking Window Frames, and Minor Piping Changes

	Year Previous		Year Following		
Month	Steam Consumption	Consumption Per Degree Day	Steam Consumption	Consumption Per Degree Day	Per Cent Saving Over Previous Year
Oct.	78,200	651	26,500	212	67.4
Nov.	417,200	730	273,200	535	26.7
Dec.	667,600	694	365,200	437	37.1
Jan.	697,300	627	510,000	473	24.6
Feb.	780,200	650	661,900	525	19.2
Mar.	775,800	593	536,000	495	16.5
Apr.	670,900	675	410,500	546	19.2
May	316,400	686	246,500	440	35.8

This example illustrates that the operation of most heating systems can be improved, but even then automatic temperature control will further increase efficiency.

Case 4—Weatherstripping Windows and Making Minor Piping Changes in Heating System

The net saving shown in Table 4 has been due to two improvements. The piping was changed so that the heating system on either floor could be turned on or off inde-


Temperature, F
Steam demand, M lb per hr
Steam consumption 695 300 lb
Steam consumption 415 900 lb
Thursday Jan. 17 avg. temp. 34 F. avg. wind velocity 11.6 m.p.h. direction southwest.
Friday Mar. 1 avg. temp. 35 F. avg. wind velocity 4.6 m.p.h. direction west.

One of the easiest means of conserving heating steam is to reduce the inside temperature during hours when the building is not occupied

pendently; this was responsible for the reduction of the total number of operating hours for the system as a whole. All windows were weatherstripped and all window frames were caulked; this reduced steam consumption materially during the hours of operation.

Case 5—Loss Due to Waste of Domestic Hot Water

Reducing waste of domestic hot water is rarely taken into consideration when contemplating ways and means of reducing building operating expense. However, waste of hot water is a large item.

Table 5 reveals the possibilities of waste if the domestic hot water system is not maintained in good condition. Loss of hot water from a dripping faucet seemingly is not great, but if there are a number of leaky faucets, the waste is serious. For instance, if the building under consideration is a hotel, and there are, let us say, 300 dripping hot water faucets, it can be calculated from the cost analysis in Table 5 that the loss would be $9 per month for the water wasted and $87 per month for steam to heat the water—a total waste of $96 per month.

An example of how steam may be wasted in a domestic hot water system is shown in Table 6. This particular

[*Continued on page 574*]

Table 5—Loss from Leakage of Domestic Hot Water

	Cost of Water Per Month[b]	Cost of Steam to Heat Water[c]	Total Cost Per Month
A dripping faucet consumes 15 gal per day[a]	$ 0.03	$ 0.29	$ 0.32
A 3/32 in. opening " 264 gal per day	0.53	5.15	5.68
A 1/16 in. opening " 943 gal per day	1.89	18.39	20.28
A 1/8 in. opening " 3806 gal per day	7.61	74.22	81.83
A 1/4 in. opening " 15,226 gal per day	30.45	296.91	327.36
A 1/2 in. opening " 60,900 gal per day	121.80	1187.55	1309.35

[a] Assuming 50 lb average water pressure.
[b] Assuming $0.50 per 1000 cu ft, the cost of water.
[c] Assuming $0.65 per 1000 lb, the average cost of steam. Assuming 1 lb of steam per gal of hot water.

Duct Design, Selection of Fan and Motor for

Fume Exhaust Systems

By **B. F. Postman***

THE most important consideration in fume exhaust is to determine the source which is producing the fumes and to isolate this section completely. Then, with the proper hoods and enclosures the application of air to this section will eliminate the source of trouble. This is more easily said than done, for in many cases it is physically impossible to hood a source of fume generation. In plants which have large floor areas and high roofs, the writer has in many instances recommended the installation of metal or fabric drop curtains to a point about 7 ft off the floor and, with window ventilation and cross drafts, has been able to eliminate fumes without having them spread. Often it is necessary to investigate whether or not the fumes are light or dense, easily dissipated or sluggish in their movement through the plant, and the effect of outside weather conditions. Definite measurement of fume travel from the source will determine the required size of hoods and the proper location of exhaust ducts.

Once fumes are allowed to dissipate in a room it is practically impossible to exhaust them. Like the proverbial mule, fumes can rarely be pulled but may be pushed out by introducing air, provided there is but one point of egress for the fumes.

Design of the Duct System

Design and layout of the duct system is important. To demonstrate how this may be tackled, a typical problem is presented:—

Fig. 1 is a diagram of four small hoods connected to the leaving and entering ends of two hot oil washers in a plant through which material is conveyed. Warm oil is discharged through a series of perforated pipes in the upper portion of the dryer in a fine spray to prevent rusting of the material (rolls for roller bearings) during progress through the plant. The fumes traveled throughout this section of the plant, even though flaps were put over both ends of the washers, and the women operators had to wash their hair practically every night due to the accumulation of oil from the fumes.

The duct system was designed in accordance with the data in Table 1 and an air friction chart, an enlarged portion of which is shown as Fig. 2. The front area of each washer was 6 sq ft. As only a small amount of fumes actually discharged from the ends of the washer and, also, as the fumes were heavy and sluggish in their travel, 50 cfm of air was used for each sq ft of washer opening, or 300 cfm. All of the portions of the duct system have been indicated on Fig. 1 and shown under the heading "Section" in Table 1. As it is usual to start at the far end of a job of this type and work toward the fan, Section (1) is our starting point.

Referring to Fig. 2, entering at the right at 300 cfm, run the edge of a triangle until it intersects the 5 in. diameter line.[1] The arrow pointing obliquely to the left indicates a duct velocity of 2200 fpm and the arrow vertically downward indicates a friction loss of 1.8 in. per 100 ft of pipe. As Section (1) is 5 ft long and the elbow is to be included with this length on the basis of 10 diameters of straight pipe for each elbow (or roughly 5 ft in this case) making a total length of pipe of 10 ft, the actual friction loss in this section will then be 0.18 in. As Sections (2), (3) and (4) are similar to Section (1), no calculations are necessary. Section (5) carries 300 cfm and it so happens that the length is 10 ft, which adds 0.18 in. to the friction loss. Section (6), similar to Section (5), requires no additional calculation.

Section (7) carries 600 cfm from two hoods. Referring to Fig. 2, entering at the 600 cfm point and traveling to the left horizontally with the straight edge until it intersects the 7 in. diameter line, the arrow pointing obliquely to the left indicates a velocity of approximately 2300 fpm and a loss of 1.4 in. per 100 ft. Section (8), similar to Section (7), requires no calculation. Section (9) carries 600 cfm and the friction in the length of 12 ft, including the bend into Section (10), is shown in Table 1. Section (10) carries 1200 cfm. Running the straight edge over to the 10 in. pipe on Fig. 2, a velocity of 2200 cfm and a loss of 0.9 in. per 100 ft is indicated. Section (11) also carries 1200 cfm. The total estimated friction loss is, therefore 1.24 in., to which is added one

[1]From the type of fumes being handled and experience a velocity between 2000-2500 fpm was assumed, and the 5 in. diameter duct was used as a starting point, as a smaller or larger diameter would have meant higher or lower velocities with resulting excessive friction loss in the small duct. As the same velocity was to be maintained throughout the system, as far as was practically possible, the 7 in. diameter duct was picked, which diameter resulted in a velocity of 2300 fpm.

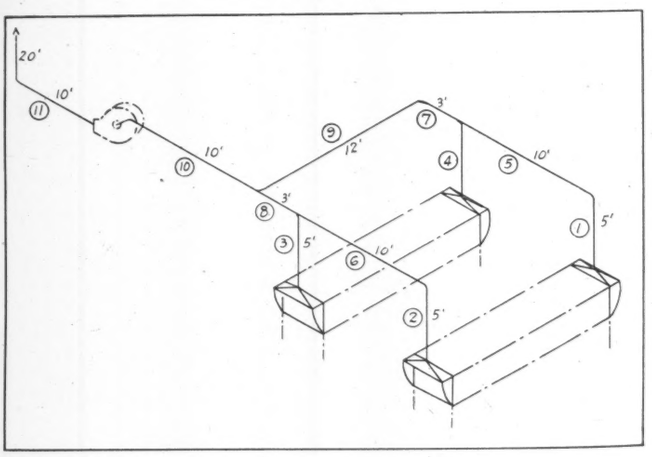


Fig. 1—Fume exhaust system, design of which is explained

*Mechanical Engineer, Hartford, Conn.

Fig. 3—Fan performance curves. Motor data in upper right-hand corner

velocity head,[2] or 0.33 in.—making a total of 1.57 in. From this data and investigating different types of fans, one having a flat paddle wheel was selected which would deliver 1230 cfm at 1½ in. static pressure requiring 0.59 hp.

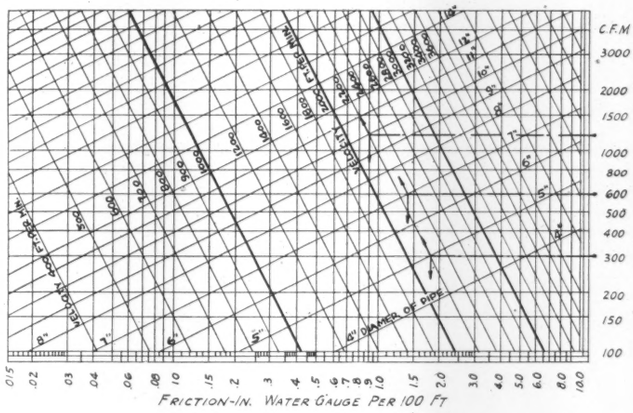


Fig. 2—Air friction chart used in design

It will be noted that the velocities have been kept almost uniform through this system, which is of great importance. The high velocities for this job might be criticized, but it should be remembered that the fumes were sluggish and heavy and, furthermore, the essential function of such a system is to remove the fumes rapidly. Many regulations call for 1000 ft velocity in piping systems, but under some conditions this will hardly affect or eliminate trouble. On some types of installations the writer has gone as high as 3500 fpm with excellent results.

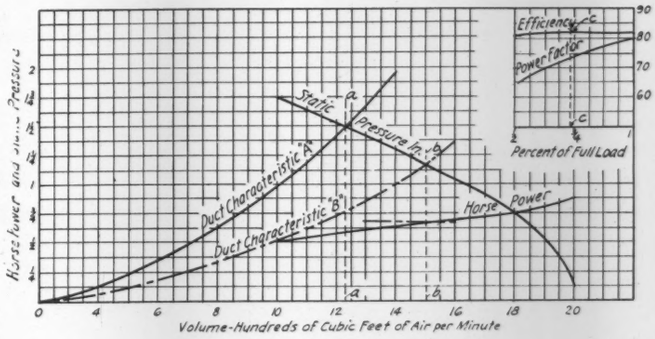
Selection of Fan and Motor

Selection of the proper type of fan, drive and motor equipment is of importance but will not be developed at

Table 1—Design of Fume Exhaust System Shown in Fig. 1

Section	Volume CFM	Velocity FPM	Dia. In.	Loss: In. per 100 Ft	Length Ft	Actual Loss Inches
(1)	300	2200	5	1.8	10	0.18
(2)	300					
(3)	300					
(4)	300					
(5)	300	2200	5	1.8	10	0.18
(6)	300					
(7)	600	2300	7	1.4	9	0.13
(8)	600					
(9)	600	2300	7	1.4	18	0.25
(10)	1200	2200	10	0.9	18	0.16
(11)	1200	2200	10	0.9	38	0.34
						1.24
One Velocity Head @ 2300 ft $= \left(\frac{2300}{4000}\right)^2 =$						0.33
Estimated total loss						1.57

[2]One velocity head is added to the total estimated friction loss in arriving at the total friction against which the fan has to operate due to the conversion of velocity pressure to static pressure in the system; this velocity head also takes care of hood entrance losses. In all cases it is to be added where high velocities are concerned. If not included, and if a fan is picked on the ragged edge as far as performance is concerned, there may be a "trouble job" to contend with.



any great length. It has been the writer's experience that the flat paddle type of fan wheel is effective where accumulations might occur on the wheel, causing it to become unbalanced. In many instances rubber covered wheels have been used and in extremely corrosive conditions, rubber covered wheels with wooden fan housings.

Checking Operation of the System

Suppose that the system is in operation and working successfully, but that the plant engineer desires to know what is actually happening. Table 1 gives the picture for the duct system. Fig. 3 shows a set of curves covering the fan performance, with static pressure in inches and horsepower plotted against volume. The duct characteristic curve "A" represents the air flow in the duct system. Where this curve intersects the static pressure curve, will be found the complete data pertaining to the system; that is, the duct characteristic curve intersects static pressure curve at 1½ in., by dropping vertical "a-a" 1230 cfm is found, and where "a-a" intersects the horsepower curve, we have 0.59 hp.

The duct characteristic curve is plotted as follows:

Let V = design volume
Let P = design pressure

$$\therefore \left(\frac{V_1}{V}\right)^2 \times P = P_1$$

If it is desired to find the pressure at 800 cfm, we have:

$$\left(\frac{800}{1230}\right)^2 \times 1.5 = 0.633 \text{ in.}$$

Other points are similarly found so that a smooth curve can be drawn.

Ordinarily there is no test instrument in a plant to help in a field test. In any fan system there are the four variables—volume, pressure, horsepower and speed. The only definite variable which can be measured is speed and if a watt-meter is handy, the horsepower that the fan uses can be obtained. From the fan performance curve as shown, or from tabular data in the fan manufacturers' catalog, the remaining two variables of volume and pressure can usually then be found.

The writer has used the following method. Data sheets were obtained from one of the electrical motor manufacturers covering power factor and efficiency of their motors of various horsepower and speeds. This data has been plotted in the upper right-hand corner of Fig. 3

for the 1 hp, 1800 rpm motor which was selected for this fume job.

At full load the name-plate data from manufacturers' tables is 3 amperes. The motor horsepower formula for 3 phase, a-c, is:

$$hp = \frac{\text{volts} \times \text{amperes}}{746} \times \text{power factor} \times \text{efficiency} \times \sqrt{3}$$

Substituting,

$$\frac{220 \times 3}{746} \times 0.80 \times 0.82 \times 1.73 = 1$$

The writer uses an ammeter in a field test of this sort. Suppose the ammeter reads 2.2 amperes:

$$\frac{2.2}{3} = 73.4 \text{ per cent of full load}$$

Finding this on the base line of the electrical curves (Fig. 3) and erecting a vertical, we intersect the power factor curve at 73.5 per cent and the efficiency curve at 82 per cent. Substituting these values in the horsepower formula, we find the horsepower taken by the fan to be 0.678.

Referring to the fan characteristic curves (Fig. 3) again, where the horizontal line representing 0.678 hp intersects the fan horsepower curve, we erect vertical "b-b." Where "b-b" cuts the base line it shows that about 1505 cfm are flowing against 1.175 in. static pressure. This is the actual condition in the system. Therefore, re-plotting the duct characteristic curve where the new vertical "b-b" intersects the static pressure curve, finishes the physical picture of the system. In other words, the fan performance rides up and down on the static pressure curve and the air flow in the duct rides up and down on the duct characteristic curve "B." Where these two curves intersect represents the actual system condition. By decreasing or increasing the fan speed, the volume and static pressure of the system will be decreased or increased accordingly.

Many trouble jobs would never have come up if the duct characteristic had been truly considered in its proper relation to the static pressure curve because when considering only one and not the other, just half of the picture is shown.

Simple Changes in Heating Systems—

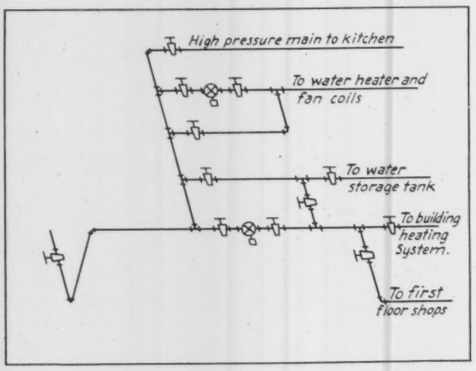
[*Continued from page* 571]

building is a drug store which serves meals at a soda fountain, and steam is used both for heating domestic hot water and heating the building. Apparently, when the system is in good condition, about as much steam is used for one as for the other.

It had been realized for some time that steam bills were too high, but recommendations to improve the system were not adopted because the cost was always apparently too great. Finally, during the summer between the two seasons shown in the table, the manager agreed to the necessary changes, which consisted of installing a new temperature regulator on the water heater and snap valves on the hot water faucets at the soda fountain. No other changes were made in the domestic water system and no changes were made in the heating system. The results speak for themselves. The savings listed for the second year range from 51.3 to 81.8 per cent monthly.

Table 6—Savings Effected by Improving Domestic Hot Water System

	Year Previous		Year Following		
Month	Steam Consumption	Consumption Per Day	Steam Consumption	Consumption Per Day	Monthly Saving Per Cent
Sept.	130,000	3939	45,000	1452	63.0
Oct.	149,300	5530	56,300	1877	66.0
Nov.	210,600	6793	88,600	2953	56.0
Dec.	227,000	7322	98,500	3177	56.0
Jan.	226,500	7550	100,500	3350	55.7
Feb.	227,000	7827	101,000	3367	57.1
Mar.	212,000	7852	103,200	3822	51.3
Apr.	255,000	8500	97,100	2856	66.3
May	243,900	7868	69,900	2118	73.2
June	176,900	6552	35,800	1193	81.8
July	207,400	6285	34,400	1146	81.8
Aug.	129,900	4059	34,100	1066	73.5


High pressure main to kitchen
To water heater and fan coils
To water storage tank
To building heating system.
To first floor shops

Separate heating mains for various building requirements are an essential part of a well planned system

Fur Storage Vault Costs

The fur storage vault of the Memphis (Tenn.) Steam Laundry-Cleaner plant opened last April, comprises a room 26 ft by 29 ft by 12 ft high maintained at 40 F, with walls insulated with 6 in. of cork and floor and ceiling with 4 in. Within the storage room is a freezing room 3 ft by 6 ft by 8 ft high maintained at 15 F, where moths are actually killed. Moths may remain dormant although continuing to actually live in temperatures around 40 degrees, but they cannot withstand being exposed to sudden *changes* of temperature below this point. If at intervals of several days garments are taken from 40 F surroundings and placed in temperatures of 15 F or less, any moths which may have been attached, will, in most cases, die. Although they can do no damage to the garment while held in the 40 F temperature, they would be free to again become active upon the return of the garment to its owner.

Each of the rooms is equipped with its own refrigeration system. The larger has two cold air diffusion units, and the smaller, 195 ft of pipe coiled along one wall connected to a compressor outside both storage rooms.

Although even identical equipment will vary in cost in different parts of the country as labor and material costs vary, and operating costs will be subject to differences according to geographic factors, the following figures may be interesting as a basis of calculation:

Cost of all material and labor for construction of storage room and freezing room, all equipment installed and ready to use, did not exceed.....$3,000

Average monthly cost to Sept. 1st of compressor water and electricity..... 8.50

—*James W. Irwin.**

*Frigidaire Corp., Dayton, Ohio.

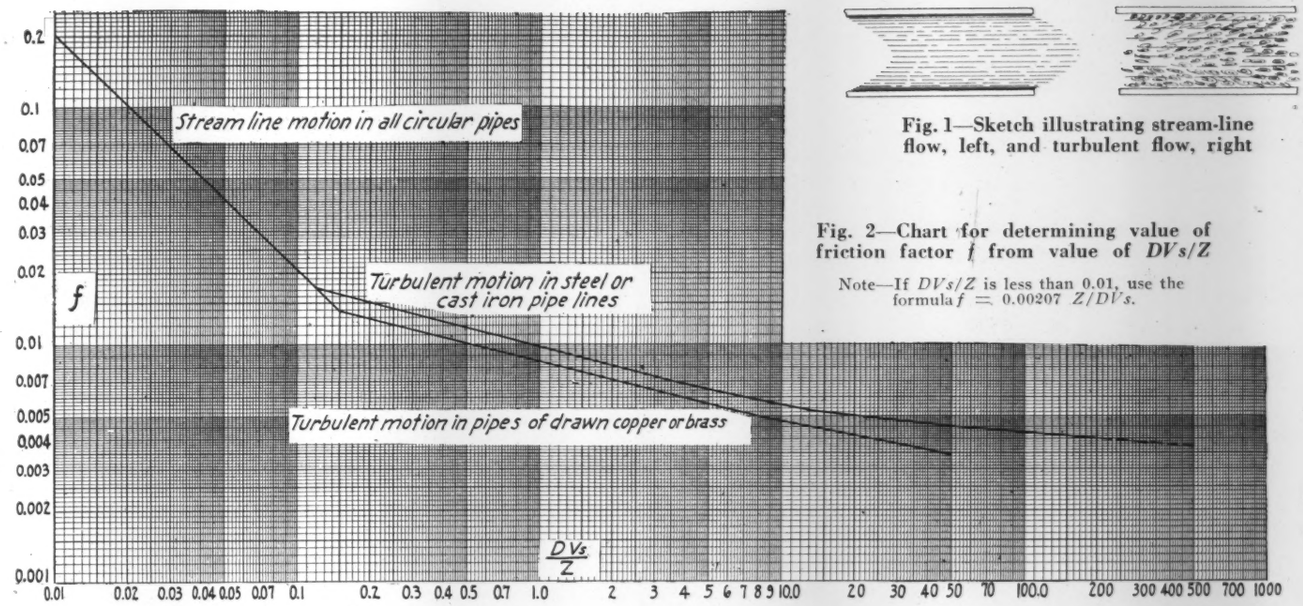


Fig. 2—Chart for determining value of friction factor f from value of DVs/Z

Note—If DVs/Z is less than 0.01, use the formula $f = 0.00207\ Z/DVs$.

Fig. 1—Sketch illustrating stream-line flow, left, and turbulent flow, right

Handling Fuel Oil

By **Kalman Steiner***

IT was pointed out last month[1] that the handling of fuel oil involves a number of subordinate operations, such as straining, pressure and volume regulation, and maintenance of correct fuel oil temperatures. Types of pumps were briefly described, a table showing the relation between viscosity, pump speed, pump type, and pump size was presented, and the importance of a tight suction line was stressed. This month, the general hydraulic theory involved in selection of the proper size piping is discussed, and data for determining pressure drop are given.

Stream-Line and Turbulent Flow

With velocity below the critical point, flow of fuel oil in a pipe is *stream-line;* above the critical velocity, flow is *turbulent.* Usually there is a small range of velocities where the flow changes gradually from one type to the other, designated as the *critical range.*

Stream-line flow is typical viscous flow, and may be likened to the manner in which the several cylinders of a telescope slide one within the other; in liquid flow there would be a great many cylinders of extreme thinness. In fact, the definition of viscosity is based upon this conception of telescoping cylinders, and it may be stated as the tendency of one layer of the liquid to resist moving at the same speed as the adjacent concentric layer, thus giving rise to the slipping effect. We need not concern ourselves with it here, but simply note in passing that the measure of viscosity is the measure of the stress developed in this slipping of the molecules over each other.

Fig. 1 illustrates the two and shows how the extreme outer layer serves as a barrier between the main body of the liquid and the rough walls of the pipe in stream-line flow; the laws governing stream-line flow are predicated upon the establishment of this outer cylinder which smooths the path of flow. In turbulent flow there no longer exists this stationary film of oil on the pipe wall. Many eddy currents are set up in the liquid body—currents moving in directions other than that of the stream itself. Hence the roughness of the pipe exerts far more influence upon the stream, and a different set of conditions prevails, which requires modification of the laws of liquid flow.

Determining Pressure Drop

As is true of all hydraulic calculations of flow through piping, the most important of the factors affecting a pipe's carrying capacity is friction, and the selection of the friction factor with suitable accuracy is the principal problem. There is no short-cut method—even an approximate one. On the other hand, means for selection of the proper factor are well developed, and with the accompanying table and charts the work of calculating is reduced to a minimum.

Most design problems in oil pumping involve viscosity, rate of flow, pipe size, pressure drop, and power consumption. All except the first are usually expressed in units either directly suitable for use in engineering formulas, or readily convertible to such units. But in the case of oil viscosity, the commonly used term of "Saybolt Universal seconds" must be converted to centipoises.

The relation between centipoises and Saybolt Universal seconds is given by

$$Z = s\left[0.22t - \frac{180}{t}\right] \qquad [1]$$

in which Z is the viscosity in centipoises, t the Saybolt seconds, and s the specific gravity. Table 1 gives values for Z for Saybolt values from 50 to 50,000 and for various specific gravities.

If the problem involves a certain pipe size, for which the pressure drop under the conditions stated is to be

* Chief Engineer, Consumers Petroleum Co., Chicago, Ill.
[1] Heating, Piping and Air Conditioning, November, 1935, p. 538.
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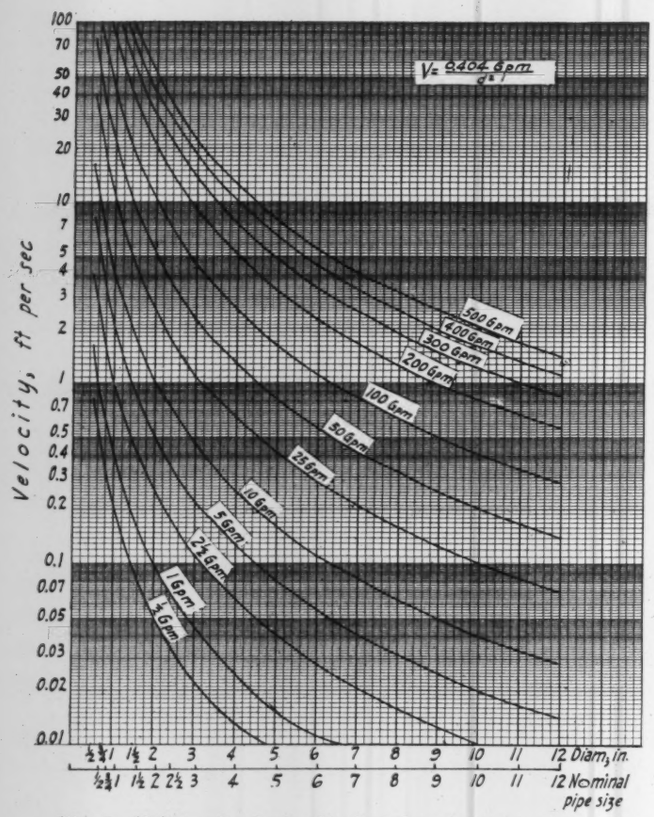


Fig. 3—Values of velocity V plotted against pipe size

evaluated, then the friction factor may be secured by referring the numerical value of DVs/Z to Fig. 2. If, however, the problem is to determine pipe size, then a pipe size must be assumed in order that a tentative friction factor may be selected. If the pipe size assumed is later shown to be incorrect, a more accurate pipe size must then be selected for a second trial calculation.

The expression "DVs/Z" is called the *modulus*. D is the pipe diameter in inches, V the average velocity of flow in feet per second (discharge divided by cross-section of the pipe), s the specific gravity, and Z the viscosity in centipoises. It should be noted that all viscosity values must be those for the fluid at the pumping temperature.

V may be quickly secured from Fig. 3, which shows values of V plotted against pipe sizes for various discharge rates, or from the relationship

$$V = (0.404 \times \text{gpm}) \div d^2 \quad \ldots\ldots\ldots\ldots [2]$$

It will be noted from Fig. 2 that the numerical value of the modulus determines the nature of the flow; *i.e.*, whether it be stream-line or turbulent. For values under 0.122 stream-line flow obtains in steel and cast iron pipe; for drawn copper and brass pipe the critical point occurs at 0.144. As was pointed out, it is clear that when the stationary film exists on the pipe wall the nature of the wall has less effect upon the friction factor than with turbulent flow.

The friction factor f having been selected from Fig. 2, it is possible to substitute in the general pipe flow formula to determine the pressure drop for the equivalent pipe length involved in the problem. This same formula holds for both types of flow; the friction factor makes the necessary corrections for whatever variations occur because of turbulence. In general form, the formula is

$$\Delta p = \frac{4fwLV^2}{2gd} \quad \ldots\ldots\ldots\ldots [3]$$

in which Δp = pressure drop, lb per *sq ft*
f = friction factor
w = density of fluid, lb per cu ft
L = total equivalent length pipe, ft
g = acceleration due to gravity, 32.2 ft per sec per sec
d = diameter of pipe, ft

The formula is somewhat inconvenient to use in this form, so the following form is derived from it by using $62.5s$ for w, s being specific gravity, changing D from feet to inches and Δp to lb per sq in. and combining all the constants, to give

$$\Delta p = 0.324 \frac{fsLV^2}{D} \quad \ldots\ldots\ldots\ldots [4]$$

in which s is specific gravity, D is diameter in inches, and Δp is pressure drop in lb per sq in.

[This is the second of a series on handling fuel oil; the next article will consider selection of the pump and motor and show typical problems in which the data given above are used. In succeeding issues, pressure regulation, strainers, metering, and control will be covered.—The Editor.]

Table 1—Conversion of Saybolt Seconds to Centipoises and API Gravity to Specific Gravity

Saybolt Seconds	Kinematic Viscos. Z/s	API GRAVITY 4	6	8	10	12	14	15	16	17	18	19	20
		Specific Gravity 1.04	1.03	1.01	1.00	.966	.973	.966	.959	.953	.947	.940	.934
50	7.4	7.80	7.62	7.47	7.4	7.3	7.2	7.15	7.1	7.05	7.00	6.96	6.91
55	8.85	9.19	9.09	8.92	8.85	8.72	8.59	8.55	8.48	8.41	8.36	8.30	8.25
60	10.2	10.60	10.4	10.5	10.2	10.1	9.95	9.86	9.78	9.75	9.66	9.60	9.55
65	11.55	12.00	11.9	11.6	11.55	11.40	11.22	11.15	11.1	11.0	10.95	10.85	10.8
70	12.85	13.4	13.2	13.0	12.85	12.68	12.5	12.4	12.3	12.24	12.15	12.1	12.0
75	14.1	14.65	14.5	14.2	14.1	13.9	13.7	13.6	13.52	13.45	13.35	13.25	13.2
80	15.35	15.94	15.8	15.5	15.35	15.15	14.95	14.85	14.75	14.65	14.5	14.4	14.35
85	16.58	17.2	17.1	16.7	16.58	16.35	16.1	16.0	15.9	15.81	15.7	15.6	15.45
90	17.80	18.5	18.3	18.0	17.80	17.55	17.3	17.2	17.08	16.95	16.85	16.7	16.65
95	19.05	19.8	19.6	19.2	19.05	18.80	18.65	18.4	18.2	18.15	18.0	17.9	17.8
100	20.2	21.0	20.4	20.3	20.2	19.90	19.65	19.5	19.35	19.25	19.1	19.0	18.85
125	26.02	27.1	26.8	26.5	26.02	25.7	25.3	25.2	24.95	24.8	24.6	24.5	24.3
150	31.8	33.1	32.7	32.1	31.8	31.4	30.9	30.7	30.5	30.3	30.1	29.9	*29.7
175	37.5	39.0	38.6	37.9	37.5	37.0	36.5	36.25	36.05	35.9	35.5	35.25	35.0
200	43.1	44.8	44.3	43.5	43.1	42.5	41.9	41.6	41.3	41.1	40.7	40.5	40.2
225	48.7	50.6	50.1	49.1	48.7	47.7	47.4	47.0	46.7	46.4	46.1	45.8	45.5
250	54.3	56.5	55.9	54.8	54.3	53.6	52.9	52.5	52.0	51.7	51.4	51.0	50.7
275	59.25	61.6	61.0	59.7	59.25	58.5	57.6	57.25	56.8	56.5	56.0	55.7	55.4
300	65.4	68.0	67.3	65.4	65.4	64.5	63.6	63.2	62.7	62.3	61.8	61.5	61.0
325	70.8	73.8	73.0	71.5	70.8	69.8	68.8	68.5	68.0	67.5	67.0	66.5	66.2
350	76.4	79.5	78.6	77.1	76.4	75.5	74.5	73.8	73.3	72.8	72.5	71.8	71.5
375	82.0	85.2	84.5	82.8	82.0	81.0	79.8	79.2	78.6	78.2	77.5	77.1	76.5
400	87.5	91.0	90.1	88.3	87.5	86.4	85.1	84.5	83.8	83.4	82.7	82.2	81.7
425	93.1	96.8	96.0	94.0	93.1	91.9	90.6	90.0	89.3	87.7	88.0	87.5	87.0
450	98.6	102.5	101.5	99.5	98.6	97.1	96.0	95.3	94.5	94.0	93.3	92.7	92.1
475	105.6	108	107	105	104	103	101	100	99.3	98.7	98.0	97.5	96.8
500	110	113	113	111	110	109	107	106	105.5	105	104	103	102
525	115.5	120	119	117	116	114	112	111.5	111	110	109.5	108.5	108
550	121	126	125	122	121	120	117.7	117.0	116	115.5	114.8	114.0	113
575	126	131	130	127	126	124	122.5	121.8	121	120	119	118.5	118
600	132	137	136	133	132	130	128.5	127.5	127	126	125	124	123
625	137.5	143	142	139	138	136	134	133	132	131	130	129	128
650	143	149	147	144	143	141	139	138	137	136	135	134	133
675	148.5	154	153	150	149	147	145	144	143	142	141	140	139
700	154	160	159	156	154	152	150	149	148	147	146	145	144
725	159.5	166	164	161	160	157	155	154	153	152	151	150	149
750	165	171	170	167	165	161	161	160	158	157	156	155	154
775	170.5	177	176	172	171	168	166	165	164	162	161	160	159
800	176	183	181	178	176	174	171	170	169	168	167	166	165
825	181.5	188	187	183	182	179	177	175	174	173	172	171	170
850	187	194	193	189	187	184	182	181	179	178	177	176	176
875	192.5	200	198	194	193	190	188	186	185	184	182	181	180
900	198	206	204	200	198	195	193	191	190	188	187	186	185
925	203.5	211	210	206	204	200	198	196	195	194	193	191	190
950	209	217	215	211	209	206	203	202	200	198	197	196	195
975	214.5	223	222	217	216	212	209	207	206	205	203	202	200
1000	220	229	227	222	220	217	214	212	211	210	208	207	205
1100	242	252	249	244	242	239	236	234	232	231	229	228	226
1200	264	275	272	267	264	260	257	255	253	252	249	248	247
1300	286	297	295	289	286	282	278	276	274	273	271	270	267
1400	308	320	317	311	308	304	300	298	295	294	291	290	288
1500	330	343	340	333	330	326	321	319	316	315	312	310	308
1600	352	366	362	355	352	347	343	340	338	336	333	331	329
1700	374	389	385	378	374	369	364	361	359	356	354	351	349
1800	396	412	408	400	396	391	385	382	380	378	377	372	370
1900	418	435	431	423	418	412	407	404	402	399	396	394	391
2000	440	458	453	444	440	434	427	425	422	418	416	413	411
2500	550	572	567	555	550	542	535	532	527	524	520	517	514
3000	660	686	680	666	660	651	642	638	633	628	624	620	617
3500	770	800	793	777	770	760	750	745	738	733	728	725	719
4000	880	915	906	888	880	869	856	850	844	838	832	827	822
4500	990	1030	1020	999	990	975	964	956	950	943	936	930	925
5000	1100	1140	1130	1110	1100	1086	1070	1065	1055	1050	1040	1030	1028
6000	1320	1370	1360	1330	1320	1302	1285	1275	1270	1260	1250	1240	1230
7000	1540	1600	1590	1560	1540	1520	1500	1490	1480	1470	1460	1450	1440
8000	1760	1830	1810	1780	1760	1736	1710	1700	1690	1680	1665	1655	1645
9000	1980	2060	2040	2000	1980	1954	1930	1910	1900	1890	1870	1860	1850
10000	2200	2290	2270	2220	2200	2170	2140	2120	2110	2095	2080	2070	2050
20000	4400	4580	4550	4440	4400	4340	4270	4250	4220	4180	4160	4130	4110
30000	6600	6860	6800	6660	6600	6510	6420	6380	6330	6280	6240	6200	6170
40000	8800	9150	9060	8880	8800	8690	8560	8500	8440	8370	8320	8270	8220
50000	11000	11400	11350	11100	11000	10860	10700	10630	10550	10500	10400	10300	10280

CHOOSING *the right* AIR CONDITIONING SYSTEM

By - - - **A. Warren Canney***

Part 8—Conclusion

THERE are an infinite number of possible combinations of dry and wet bulb delivery conditions and air volumes which will maintain desired psychrometric conditions of the air in conditioned spaces, as was explained in October. This fact, but little realized, is of vital importance.

It has been shown that the minimum delivery conditions chosen establish to a major degree the economics of the entire investment, and throughout this series (of which this is the concluding article) it has been repeatedly brought out that the establishment of these delivery conditions should be based on an analysis of air distribution requirements. The limitations of choice for economic balance *then* lie between the extremes which in turn lie within satisfactory requirements for air distribution. In general, if there is but little ductwork, the delivery conditions for best economic balance should lie toward the right on the ratio line discussed on pp. 471-472 in the October issue. If there be considerable ductwork, then these entering conditions should shift to the left with the possible use of aspirating outlets which, dependent upon requirements, will induce more local recirculation as the entering air conditions approach the saturation point.

Small jobs as well as large ones of the type controlled by these instruments require careful engineering analysis to assure satisfactory results. This air conditioning control board was designed by the author for the N. B. C. Radio City studios

It thus becomes perfectly feasible to design systems which depart widely in fan and duct sizes, refrigeration, power, steam, gas, or water requirements but which will produce desired temperatures and relative humidities. In this we see a wide latitude which saves the neck of many an installation while encompassing all purchases made on a capacity guarantee basis only.

There are two other major matters: First, the use of an adequate outdoor air volume and, second, the arrangement of the system so that proper, sufficiently smooth, exacting, and economical control will result. The amount of outdoor air greatly influences the required refrigeration capacity. Is it, then, fair practice to permit bidders to assign their own values when there is to be no contract guarantee regarding atmospheric wholesomeness?

This is one of the principal weaknesses of uncontrolled air conditioning quotations. The surface has hardly been scratched in the setting up of scientific standards of wholesomeness. Under the intensive pressure of uncontrolled bidding there can be only one tendency, and that is to supply a minimum volume of outside air. The author has seen these figures vary by 500 per cent and has listened to the most vigorous defenses of each.

While unscientific, the outdoor air volume specified on a per person basis is the most practical yardstick today. This should not be less than 15 cfm per person for adequate purging, and only scaled down to 10 where spaces are very small, with low ceiling height and with not less than 100 sq ft per person.

Emphasis today is so much on temperature and humidity guarantees that in nine cases out of ten outdoor air volumes are assigned with little regard to assuring that they will be secured; and yet it is obvious that in spending money for air conditioning an owner does not want to incur any penalty, such as stuffiness, for the sake of improved temperature and humidity conditions. Aside from not recognizing and offsetting difficulties productive of dissatisfaction in air distribution through lack of first-hand experience or oversight resulting from estimating under pressure, or from a multitude of other details, it is the author's feeling that there is less known and being done about atmospheric wholesomeness than any other matter in general air conditioning practice.

The buyer's emphasis is on comfort, for he wants to translate his dollars into that one result. Most buyers today are not yet aware of the numerous objectionable factors which *can* be *potentially* introduced by virtue of the presence of an air conditioning system. The business man wants comfort for dollars and soon learns that psychrometric stipulations establish comfort—so he accepts *their* being guaranteed. The bidders, on the other hand, know that there is many a "slip 'twixt the cup and the lip" in the successful fulfilment of air conditioning contracts, so emphasis is naturally and properly placed upon a temperature and humidity guarantee, but which is only valid when and as a dozen or more reservations controlling the maximum heat load are peak. This occurrence is so rare that the customary air conditioning guarantee from both legal and practical standpoints actually provides only a capacity guarantee, and amounts to a performance guarantee but one operating hour in ten thousand, on the whole in practice. This often results

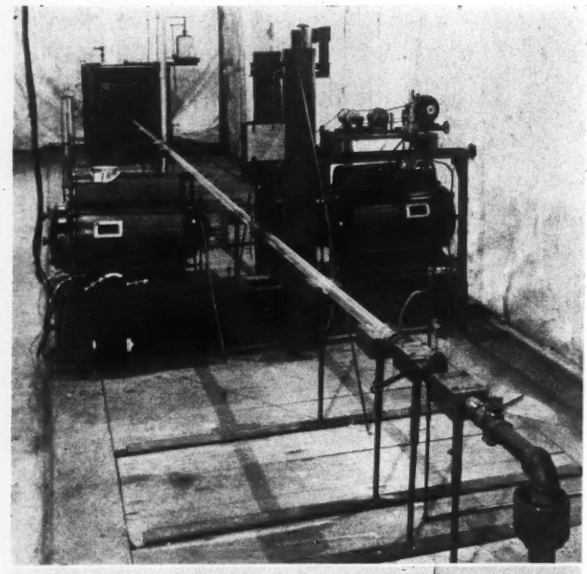
(*Continued on page* 585)

*Engineer in charge of air conditioning, Clyde R. Place, Consulting Engineer, New York, N. Y., Ernest Williams, Manager.

Flow of Water in Piping Studied with Movie Camera; Results Described Here

By **Edgar E. Ambrosius*** *and* **John C. Reed***

The motion picture camera offers a new method of studying flow of water in a glass pipe which has certain advantages over other methods. Some of these advantages are: (1) permanent records are obtained; (2) no mechanical or other obstructions are introduced into the stream to disturb the flow; (3) it is applicable to high and low velocities; (4) a complete traverse of the entire pipe is made at each exposure; (5) study of acceleration and deceleration is permitted; and (6) the study of other devices such as orifices and venturi sections is possible..... From the results it would appear that maximum turbulence occurs at a point, or in an annular ring, equal to about 0.85 of the radius. Since there is a minimum amount of velocity fluctuation at the center of the pipe, there is little turbulence there.....It can further be concluded that the pitot tube, because of inherent defects, will give velocities that are high, and the magnitude to which they are high will depend on the magnitude of the velocity fluctuations..... This new method of studying fluid flow, the practical features of the results obtained, and other uses of the method are briefly described



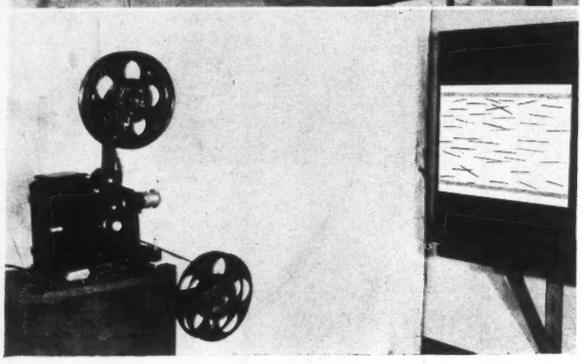


Fig. 1 (*above*)—Apparatus for studying flow of water in glass pipe. . . . . Fig. 2 (*below*)—Filmascope used to project one frame of film on screen for analysis

MUCH time and energy have been spent on study of fluid flow in closed conduits, but only fair agreement may be found among many investigators. A review of this situation prompted the writers to study the flow of water to secure information relative to velocity distribution curves, turbulence, etc.

The method used was an "undisturbing method" as contrasted to other investigations made with apparatus part of which was placed directly in the fluid stream. Our study was made possible by projecting a thin, flat sheet of very intense light through the horizontal diametral plane of a glass pipe. The light was reflected from small globules of an insoluble mixture, having the same density as that of the water, just as dust particles are made visible by a beam of sunlight in a darkened room. Photographs of these particles were taken with an ordinary studio motion picture camera.

The hydrodynamic laws governing the laminar flow region are well established. We concluded, therefore, if our method gave data for this region which agreed with the existing laws, the method must be good, and could be applied to the turbulent flow range. It will be shown that the method was applied to both types of flow with gratifying results.

The Test Set-Up

The apparatus, Fig. 1, consisted of a steel tank and two 20 ft sections of 1¾ in. circular glass pipe. The pipe extended about 16 in. into one end of the tank and was

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provided with a smooth belled mouthpiece. The initial disturbances of the water entering the tank were reduced to a minimum by a gravel baffle and the water in the tank was maintained at a constant level. At the outlet end of the pipe was mounted a quick closing and calibrated 1½ in. plug valve.

Two high intensity arc lamps illuminated a thin horizontal diametral plane of the pipe at the observation section and the motion picture camera was mounted vertically above the pipe at this point. The observation section, approximately 180 diameters from the pipe entrance, was surrounded by a glass water box, which eliminated distortions caused by the curvature of the circular pipe.

Characteristics of flow were determined by a study of the motion of minute particles in the water by means of the motion pictures as the water flowed through the pipe. Movement of the water was determined as follows: Small globules of a mixture of carbon tetrachloride and benzene were injected into the water as it entered the pipe. These globules were insoluble and had the same density as the water, and it was assumed that their presence did not influence the characteristics of flow. When the thin sheet of light was passed through the pipe, the globules reflected the light and were thus photographed.

After the pictures were taken they were projected, one frame at a time, on a screen (Fig. 2). As each picture was a definite time exposure, the resulting streaks represented the distance that the particles traveled in the corresponding exposure time. Any particle was, therefore, definitely defined as to velocity, direction, and position in the pipe. If a sufficient number of these streaks for a given average velocity be placed to a common reference line, and in their correct position relative to the pipe wall and diameter, the opposite ends form the velocity profile.

Results of the Study

The distribution of velocities in the pipe for different conditions of flow were found in this manner. The average velocities resulting from these distribution curves were compared with those obtained by weighing the water discharged, which revealed remarkable agreement since the maximum difference was but approximately one per cent.

It is interesting to note in Fig. 3 the manner in which the observed points or velocities fall on a smooth curve in the case of laminar flow. One can see that this distribution curve is almost a true parabola; for example, the average velocity as determined from this curve is approximately one-half of the maximum and is attained on the curve at a distance of about seven-tenths of the radius. The average velocity as determined from this profile checks that obtained by actual calibration within one-half of one per cent.

The instant turbulent motion set in, the motion pictures revealed that the smooth distribution of points (velocities) no longer existed. Instead, the average velocity curves were represented by a wide spread or band of points. The reason for this is that eddy motions are superimposed upon steady flow.

A typical example of the velocity distribution when turbulent flow conditions exist is shown in Fig. 4. The spread of points, or the fluctuations of velocity represented by these points, above and below the average velocity distribution curve is unique. This condition was common to all the different conditions observed for turbulent flow. The extent and magnitude of this spreading of points has a practical value since it explains why velocities obtained under similar conditions by means of a pitot tube are always high. The reason for this is explained as follows: Suppose U be the mean velocity component with respect to time in the direction of flow. This component can be broken up into two parts, one designated by u, independent of time, and another u', having the fluctuations with respect to time. It is generally agreed that the pitot tube manometer does not indicate the mean value of u, with respect to time, but a value of the pressure difference which is proportional to U^2. In the equation

$$U^2 = (u + u')^2 = u^2 + 2uu' + u'^2$$

the mean value of $2uu'$ vanishes, where u'^2 does not; it will however, always be positive. It is for this reason that a pulsating velocity occurring in a short time interval will cause a pitot reading to be high. If the variations of velocity are as large as ± 25 per cent, then

$$U = u\sqrt{1 + \left[\frac{u'}{u}\right]^2} = u\sqrt{1 + \left[\frac{25}{100}\right]^2} = 1.0315u$$

and the value of U is about 3 per cent high. With the average fluctuations as found in this work and shown in Fig. 5 one can readily see that the pitot tube would give erroneous results. Such resulting velocity distribution curves would be in error, and the maximum error would occur at the point of greatest velocity fluctuations. Or stating it in another way, the maximum error occurs at the point of greatest turbulence.

Sudden Stoppage of Flow

A feature which has been studied and which is worthy of consideration because of its practical application is the phenomena of sudden stoppage or retardation of flow. The motion pictures revealed a violent backward motion

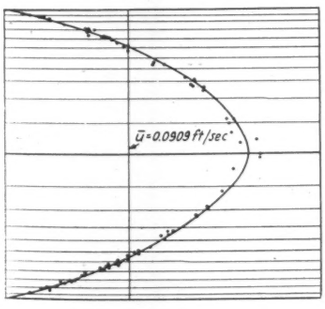


Fig. 3—Distribution of velocity, showing data as determined in laminar flow

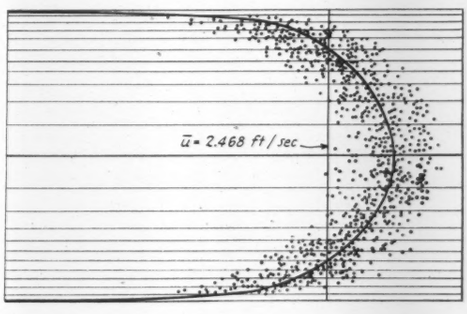


Fig. 4—Distribution of velocity, showing data as determined in turbulent flow

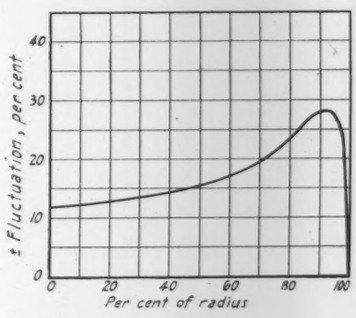


Fig. 5 — Velocity fluctuations across pipe diameter

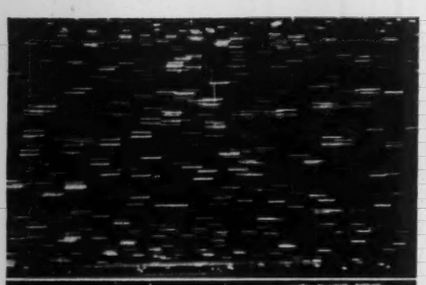


Fig. 6—Enlargement showing laminar flow

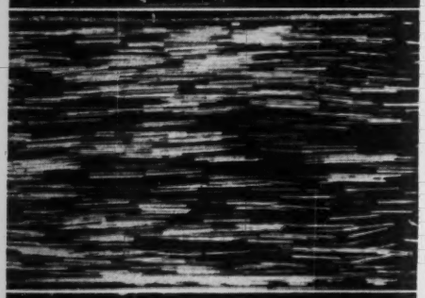


Fig. 7—Enlargement showing turbulent flow

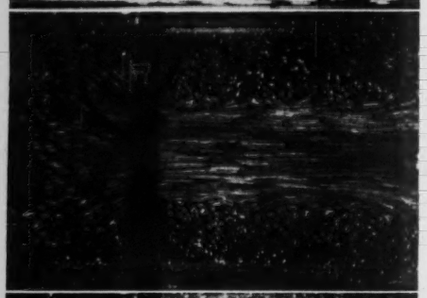


Fig. 8—Enlargement showing flow through an orifice

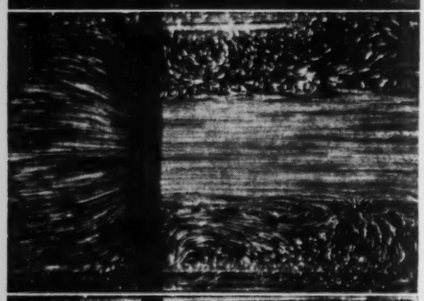


Fig. 9—Enlargement showing flow through an orifice

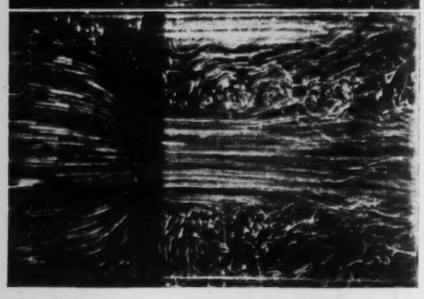


Fig. 10—Enlargement showing flow through an orifice

of the water near the pipe wall when the flow of water was suddenly stopped. The reason is that each stream line has its momentum changed the same amount, when there is a sudden retardation, because each stream line is subjected to the same pressure differences. Hence, when the outlet valve is suddenly closed, each stream line has a negative change of velocity equal to the original average velocity in the pipe. The particles in the center of the pipe continue to move forward with decreased velocity, but those near the wall, having initially a very small velocity, are caused to move backward with a velocity nearly equal to the average velocity. When the conditions of flow are turbulent, before the sudden closure of the valve, the backward velocities near the wall are relatively greater than under laminar flow conditions because the average velocity is relatively greater.

The motion resulting from the sudden retardation or stoppage of flow is very unstable and lasts for only a few seconds, due to viscosity and friction. Therefore, the orderly condition which exists just after sudden stoppage is quickly reduced to a condition of complex intermixing, due to instability. During the brief stable period after valve closure the volume of water moving forward should equal the volume which is flowing backward, since the average velocity must be zero. It was quite easy, by the method used by the writers, to determine the volumes of fluid flowing in both directions and it was found that these volumes checked within a very small fraction of one per cent. The phenomena just described and which can be seen from the pictures explains in part the rapid decrement of the magnitude of successive pressure waves encountered in water hammer, which is accounted for by the dissipation of the kinetic energy remaining after a sudden change of velocity in a pipe.

Scrubbing Action on Pipe Wall

The motion pictures revealed still further that a sudden retardation of flow produced a scrubbing action along the wall that may have practical value; for example, by preventing ingredients in suspension from adhering to the pipe walls or settling out, or in keeping ingredients in suspension, due to the violent turbulence produced. Certain experiments have been made to determine the effects on the rate of heat transfer due to the scrubbing away of the quiescent fluid layer along the wall of the pipe. However, no conclusive results have as yet been obtained.

To give the reader a better conception of laminar and turbulent flow, enlargements are shown in Figs. 6 and 7. From these pictures one can readily note the difference between the two types of flow and, also, that it was a relatively simple matter to analyze the pictures.

Flow Through an Orifice

Figs. 8, 9 and 10 show the flow of water through a simple orifice. They display a great amount of detail and by making observations of the regions above and below the orifice it is possible definitely to locate the *vena contracta* and possibly to determine the best location for pressure taps. This method of analysis can also be applied to a venturi section.

Revise Steam Pressures in Steel Fittings Standard

An addendum to the American Standard for Steel Flanged Fittings and Companion Flanges (B16e-1932), revising Table I of the 1932 edition of the standard, has been approved by the *American Standards Association,* 29 W. 39th St., New York, N. Y., with the symbol B16e1-1935. The addendum covers adjusted steam service pressures for temperatures below 750 F.

Copies of the addendum will be given free to any one ordering the American Standard for Steel Flanged Fittings and Companion Flanges (B16e-1932). Any one who has a copy of this standard may write for the addendum, which will be sent without charge.

Modernizing with Air Conditioning

By **Terry Mitchell***

OFFICE building modernization by air conditioning is a rapidly increasing application which requires careful design in order that the type of job selected for the particular building will meet the requirements economically and efficiently. A number of interesting features are incorporated in the system recently installed in the 10 story building of the National Reserve Life Insurance Co. at Topeka, Kansas, which building was erected 10 years ago, and are briefly described here. The entire job is handled by a refrigerating system of 131 tons capacity. Not only is direct expansion "Freon" used throughout, but the condenser and receiver are located on the roof 130 ft above the three compressors in the basement. The building is divided into 38 zones, separate controls being used for regulating the conditions in each to suit occupancy, outdoor temperature and humidity, and sun heat load.

Three Compressors Offer Eight Capacity Groupings

Two of the three enclosed type refrigeration compressors have cylinders of 8¾ in. bore by 6 in. stroke, while the third unit is a 7¾ by 5. Each of the large machines is driven by a 50 hp motor, the smaller one being operated at either of two speeds by a 40-20 hp motor. A multiple-step controller selects the right combination of machine capacities to match the load, and the grouping of horsepowers offers the equivalent of eight machines: 20, 40, 50, 70, 90, 100, 120, and 140 hp.

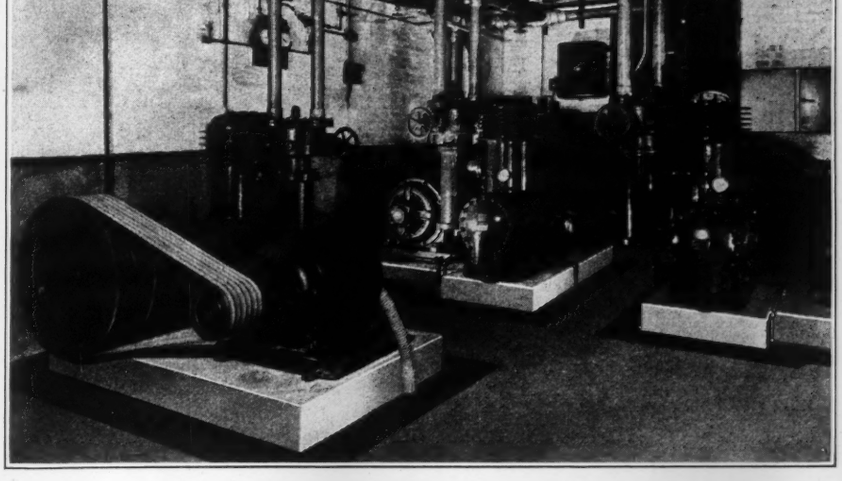
The suction and discharge lines of the three machines are interconnected, and piping to each of the crankcases distributes the oil returning with the suction gas. Gas equalizing lines connected above the oil level in the crankcases prevent the tendency of any one machine which might be operating from sucking out the oil in the others. At the bottom of the main discharge riser there is an extension pipe in which any oil in the line is allowed to collect; as the oil builds up, it trips a float switch, opening an electric shut-off valve and permitting the oil to drain into the crankcase connections. The two larger machines have automatic starting bypasses which relieve the head pressure until the machine comes up to speed.

The main discharge line is 6 in. copper with soldered connections; it runs vertically through a 3 by 4 ft shaft to the roof where it enters the horizontal shell and tube condenser. Total run of this line is 160 ft—probably a record for this class of service. The main riser is secured by hangers and is supported at the top by a cable which passes over a wheel to a 350 lb counterweight. The multipass condenser, 30 in. by 15 ft, is so placed under the 1050 gpm cooling tower that the water runs over the outer surface of the shell, adding more than 11 per cent to the effective surface.

Primary reason for arranging the plant with the condenser and receiver on the roof was to avoid the heavy increase in head pressure that would have been caused if the liquid refrigerant were forced upward in a column 120-130 ft above the engine room. By raising it to the roof while in the form of hot gas the extra pressure on the condensing system is negligible. The necessity for moving the condensing water to such a great height was also eliminated by putting the cooling equipment on the roof with the tower.

The condenser is underneath the receiver. Level of the liquid in the receiver is so nearly constant while the plant is running that any material lowering of it would

*Frick Co., Waynesboro, Pa.



The 10 story National Reserve Life Insurance Co. office building, built in 1925, recently modernized with air conditioning. Building exterior is shiny white tile, and all windows are equipped with white venetian blinds. . . . The three compressors in the basement provide a total capacity of 131 tons; a multiple step controller selects the proper grouping to match the load

Air conditioning an existing building presents many problems not encountered in designing a system for a new building; the conditions of each job determine the type of system to be installed.....Last month, the application of an indirect system to a building was described, chilled water from the refrigeration equipment in the basement being circulated to the conditioning equipment . . . . . The job briefly described this month includes direct expansion units for 38 zones in a 10 story building, compressors in the basement, condenser and receiver on the roof directly under the cooling tower.

indicate a refrigerant leak; a float switch opposite the receiver is connected to a light and alarm bell in the machine room to warn the engineer of the difficulty.

After leaving the receiver, the liquid refrigerant passes through a new type of drier charged with alumina gel, and a filter which comprises a series of thin steel discs spaced 0.008 in. apart; by means of a handle outside the filter case the discs can be turned past a set of fine plates extending into the spaces between them for cleaning. The liquid next drains to the direct expansion air conditioning units on each floor. The ground floor has a separate blower unit for each of the stores or rooms; on each of the other floors of the building a single unit supplies the various rooms through ducts. Units on the upper floors are located in the janitor's closet, adjacent to the pipe well. The liquid feed to each unit passes first through an electrical control valve, which provides positive opening or closing of the line, and then through a thermostatic expansion valve.

Control Is by Zones

The volume of the conditioned air supplied to each zone is regulated, depending upon changing temperatures and humidity conditions inside; these inside conditions are also varied in relation to those outside. Features of this compensated effective temperature control method include electrical operation on low voltage throughout with proportioning type gradual action thermostats and humidistats operating damper motors. There are four zones on the second floor, and all other floors up to and including the ninth have three zones; the tenth floor has five. The control units for each zone comprise a thermostat, humidistat, and a small motor to operate a volume damper in the duct which delivers conditioned air to that zone. The control devices which modulate the motor and damper select the proper effective temperature needed for comfort, as compared with prevailing outside temperatures. An outside thermostat determines the control point of the inside thermostat and humidity controller.

The compressors come into action one after another as the suction pressure rises. An increase in pressure of 1½ lb causes the control system to start another machine, or combination of motors, the tendency being always to hold the suction pressure fairly constant. An extra panel in the machine room provides remote control of the central conditioning unit on each floor, and of the control system for each zone, this being so arranged that the zones can be operated independently of each other.

On the conditioning unit itself there is provided an economizer control for the outdoor air supply which responds to outdoor temperature to open the outdoor air dampers when outdoor air is suitable for cooling. A humidity controller prevents the opening of the outdoor air damper, or closes it so that only 1,000 cfm of air is admitted at times of excessively high humidity outside, such as during a rain. The blower units used on most of the floors include eight coils each of six rows, with an 18 in. by 48 in. face area and have a blower driven by a 2 hp motor. Each unit provides 17 tons of cooling capacity.

The blowers operate continuously whether the refrigerant is off or on. The air leaving each of the rooms (on the floors above the first) returns to the hallway through a grille in the bottom of the door, and from the hallway is recirculated through the ducts. No special outdoor air inlets were provided on the first floor, this being taken care of by the opening of doors and windows. A portion of the air escapes through the window cracks due to the pressure inside the building.

The heating system already in the building takes care of the winter load, but the blowers will overcome the resistance of preheating coils which later may be installed for tempering the outdoor air taken in through the ducts for ventilation purposes. At present, each blower handles 5,500 cfm of which between 1,000 and 2,000 cu ft is outdoor air. Both outdoor and return air passes through a filter.

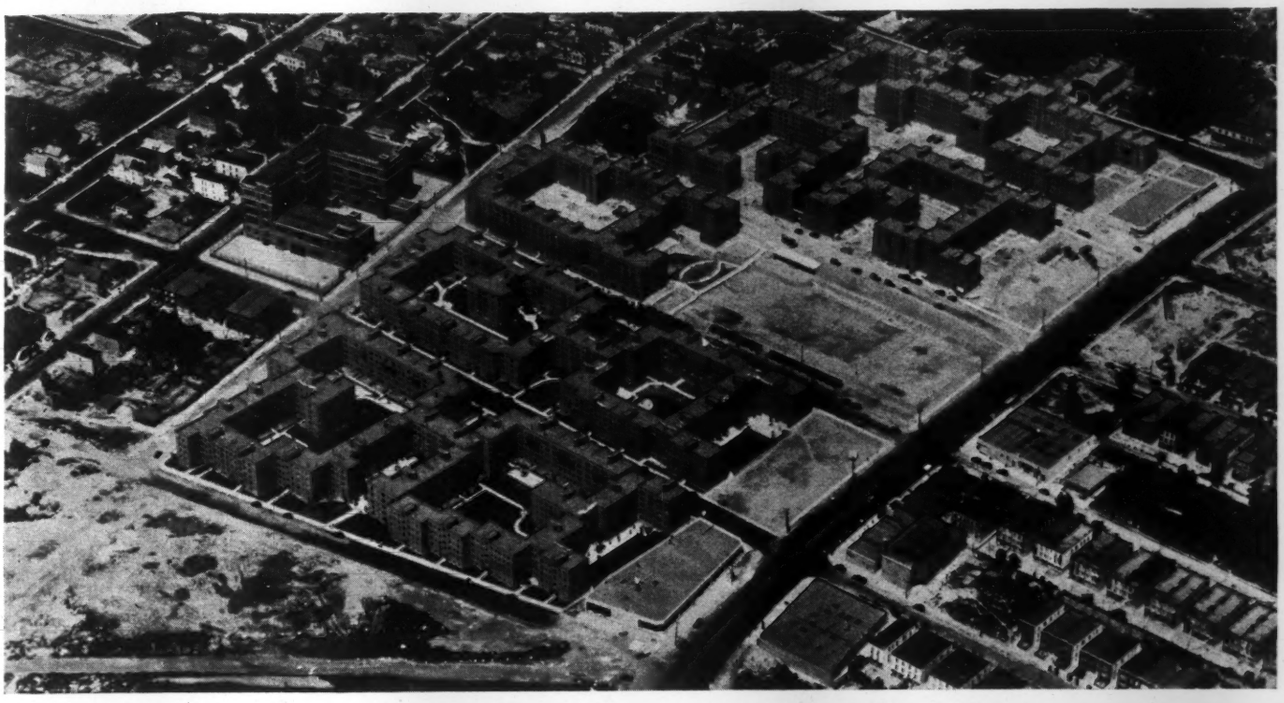
Duct System Is Unique

The duct system is unique. Three trunk lines come off the unit—one doubling back of the unit to supply the rooms in that direction and the other branch going straight ahead, catching the rooms in the front of the unit on the same side of the hall; the third branch crosses the hall and spreads both ways to supply that side of the building. An archway was built in to conceal the duct as it crossed the hall, and all ducts were metal lathed and plastered and were made to look like beams.

The ducts thus allow the building to follow its standard procedure when erecting new partitions for special offices, while always having an air outlet into each room. In some places there are now two outlet grilles not 8 in. apart, but this will allow space for the partitions when needed.

The system is guaranteed to maintain 85 F dry bulb and 71 F wet bulb inside with 100 F dry bulb and 77 F wet bulb outside. Population load was based on 100 persons for the first floor and 40 persons for each of the other floors. The system has operated satisfactorily through the past season. Head pressure has never been above 130 lb gauge despite 108 to 110 F weather with very high relative humidity. As anticipated, the air conditioning has attracted new tenants to the building.

The Capital City Iron Works Co., Topeka, was awarded the contract.



Aerial Explorations, Inc.

Air view of the Hillside Development, Bronx County, New York, comprising 5 principal blocks divided into 110 sections of 4 story and 6 story apartments

Heating the Hillside Housing Project

By **H. G. Schaefer*** *and* **Lewis Smith†**

ONE of the most important housing projects—and one of the largest—undertaken with Federal aid is the development for the Hillside Housing Corp. in Bronx County, New York City.

In the northeastern corner of Bronx there are hills overlooking Long Island Sound; on the highest stands a mammoth group of apartment buildings, completed last summer. This is Hillside. The property includes 9 acres, but only one-third of the land is covered by the buildings. There is one large play ground of 2½ acres, smaller open spaces, a wading pool and an outdoor theater. Landscaping is progressing rapidly.

Architect for the project was Clarence S. Stein with Frank E. Vitolo as associate architect. The mechanical and electrical engineers were Eadie, Freund and Campbell, and M. C. Giannini. The general contractor was Starrett Bros. and Eken, who employed Baker, Smith and Co., as heating contractors. Total cost was nearly $6,000,000.

There are 5 principal blocks, divided into 110 sections of 4 story walk-up apartments and four 6 story elevator apartments. There are about 5000 rooms. The arrangement is such that almost every apartment has two exposures. The buildings are narrow and irregular. With sea breezes to blow across the hill top the rooms should be delightfully cool in summer, but for these same reasons they present a problem for efficient heating.

This is not a "slum clearance" project. The Bronx does not have slums, and the site was clear of buildings anyway. Nor was the rental, fixed in advance, such that extremely low income dwellers would be attracted. Neither is it a speculative project. It is of the limited dividend type to provide a fixed return on the investment under the laws of the State of New York, and by the conditions under which the Government loan was granted. Hence every effort was made to reduce the first cost, but as operating cost is naturally equally important, every decision was influenced by the proper relation between the two.

The buildings are of brick, with center steel columns, the framing beams bearing on the outer walls. Concrete arches, troweled smooth to take the mastic base in which

One of the most important of the housing projects so frequently mentioned in the day's news is that for the Hillside Housing Corp., for which a PWA loan was granted; the buildings were completed last summer.....Described here is the method of heating used and the control system.....Economic balance between first and operating costs is of course extremely important on projects of this kind

* Field Superintendent, Baker, Smith & Co., Inc., New York, N. Y.
† Eastern Division Manager, C. A. Dunham Co., New York, N. Y.

the finished hard wood floors are set, were poured in wooden frames. A 4 ft deep pipe space under the basement floor arch houses steam, plumbing and electric lines. Access doors are provided at frequent intervals.

Low Pressure Boiler Plant for Each Block

Owing to the topography and the shape of the buildings, a central heating plant was not used. Instead there is a low pressure boiler plant in each of the five blocks. The four large blocks have in each plant three riveted steel fire box oil burning boilers, each about 150 hp, while the smaller center block has two such boilers. These are set on red brick foundation walls 4 ft high. The combustion chambers are paved with fire brick and insulating brick over terra cotta blocks with the voids aligned so as to provide ventilation. The foundation walls are reinforced with steel angle frames built in, with the front members drilled and tapped to take the steel plate fronts on which the oil burners are mounted. The furnaces are lined with No. 1 fire brick laid up with a considerable batter to insure stability and to reflect the heat upwards. No bond exists between the foundation wall and the furnace lining.

Oil burners are of the rotary mechanical atomizing type. In each plant one boiler is arranged for full automatic control, the others being manually controlled. No. 6 fuel oil is stored in cylindrical tanks buried in the courts adjoining the boiler rooms; these tanks vary from 15,000 to 25,000 gal in capacity. Pumps with V-belt drives circulate the oil through electric heaters for starting up and thence through shell and tube type heaters for normal use. The latter are set below the boiler water line and are piped to two special pads built into the boiler walls, thus providing a gravity hot water circuit for oil heating. These pads are riveted steel flanges, tapped 2 in., provided for oil heater connections. The boilers are protected automatically against low water, delayed combustion, and oil or air failure.

Steam is generated at a normal range of from 2 to 5 lb, the limits between which the automatic boiler control for the one boiler is set. The operator adjusts the combustion rate of either one or two of the manually controlled boilers to take care of the load. The automatic unit cuts in and out to care for fluctuations in the load.

Two separate return systems are used. The returns from the water heaters, with drips from the boiler headers, are taken to a duplex condensation pump. The returns from the heating system come to a duplex vacuum pump. Each boiler is fed through a Hartford loop and there is an equalizing header in the returns at the boilers. All returns are graded so that condensate can flow by gravity to the sewer if necessary.

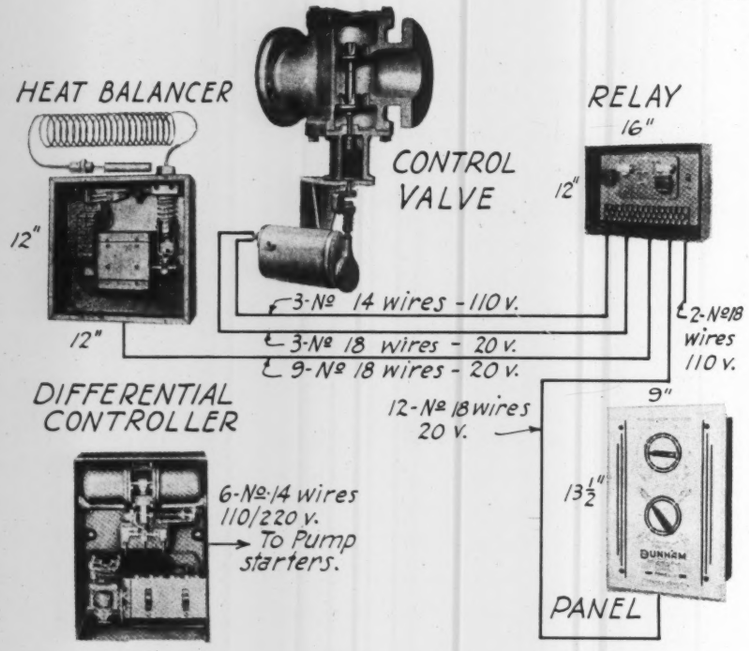
The smoke breechings, at the point where they enter the stacks, are provided with balanced barometric dampers so counterweighted that they furnish check-draft air to the stacks. This maintains constant gas density in the boilers regardless of load or of atmospheric conditions. The stacks themselves are of brick, lined with No. 2 fire brick to a height of 60 ft.

Steam is carried to a main header, from which one main is carried to the water heaters and another main feeds the heating system.

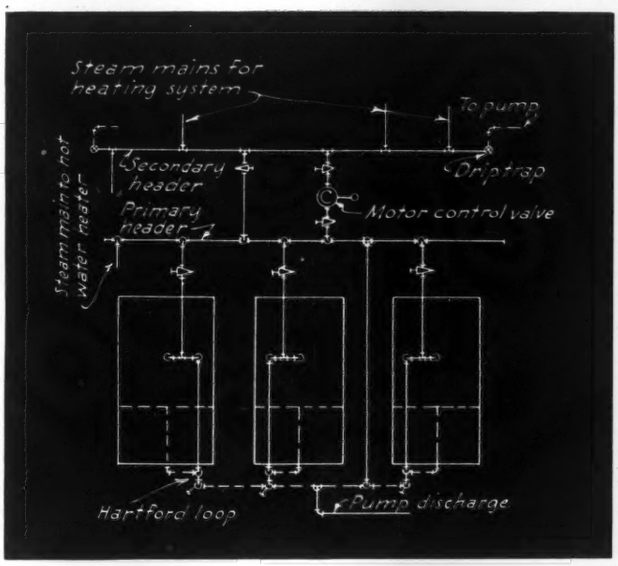
Heating System and Control

In determining the design of the heating system and its control, a number of questions had to be settled. Fuel is the largest single item of operating cost, so it is of the utmost importance to heat the buildings economically yet with full satisfaction to the tenants. At the same time the installed cost had to be kept to a minimum. Maintenance cost was also weighed, along with simplicity and ease of operation when placed in the hands of ordinary fire room attendants.

Zoning for exposure was considered but discarded. The construction and shape of the buildings is such that a single steam main through the center could be used, with branches both ways to the risers; to zone the buildings would require mains on both sides. With most of the apartments facing in opposite directions, open doors between the rooms would tend to nullify zone control of



Method of heat control as used at Hillside



Typical boiler installation and header arrangement

heat. The first cost of zoning was therefore considered to be out of proportion to the benefit.

Cast iron radiators were used throughout in the living and bed rooms, the kitchens and bath rooms having heat risers to reduce first cost. On the upper floors these heat risers extend horizontally for 6 ft at the ceilings to allow for roof loss. All risers are vented through thermostatic traps to the nearest return line.

In a project of this size, annual fuel expense is so large that even a small percentage saving is a big item. A difference of 25 per cent might mean the difference between earning the full return on the investment and not earning it. Including heat risers, the total equivalent direct radiation is 180,000 sq ft. It was calculated that for a normal winter 954,000 gal of oil would be required. Using a price of 4c per gal, a 20 per cent difference in fuel consumption equals $7632 and 25 per cent equals $9540 per year. The problem, then, was to find a control method which would be economical yet give complete satisfaction to the tenants.

The method adopted provides for continuous steam circulation with radiators filled with sub-atmospheric steam in mild weather, and for throttling the steam in each block. Continuous circulation is expected to reduce pipe corrosion by restricting the amount of oxygen admitted to the piping, and to prevent excessive expansion and contraction of the piping. The installation of the control valve for each block is shown in the sketch of the headers. Partial closing of these valves creates a natural vacuum in the radiators to vary radiator temperature over a wide range. To maintain circulation under a vacuum, differential controllers are connected to the vacuum pumps to keep slightly more vacuum on the return lines than exists in the supply mains.

Considerable thought was given to the question of thermostatic control. Since competent firemen were to be on duty in the boiler rooms and since semi-automatic means were available at comparatively small cost, that method was adopted to control steam temperature. In each block a thermostatic heat balancer was inserted into and connected with one radiator. This device is sensitive to the steam temperature which is a function of the vacuum in the system. The vacuum is to some extent affected by the room temperature. The device is set by electric control from the boiler room for a given vacuum, according to the weather conditions. The fireman is guided as to the amount of vacuum needed by a recording thermometer and by his own observation of other weather conditions such as wind velocity and direction, and sunshine or rain. When set for a given vacuum the heat balancer automatically maintains the control valve opening at the correct position to produce that vacuum.

Each radiator valve is fitted with a thin phosphor bronze regulating plate held in the face of the valve union. These plates balance the steam flow so that all radiators receive steam at about the same time and in proportion to the size of the radiator. They serve a further purpose in that by changing the plates the temperature of any room can be raised or lowered by several degrees without affecting the system performance. These plates are provided with larger openings than orifice plates because of the larger volume of rarefied steam to be handled. They do not retard or interfere with the steam circulation.

Choosing the Right System

(*Continued from page 577*)

in unintelligent buying, inadequate contracts, and loss of perspective by both parties, so that many vital factors are apt to be lost sight of. Among these factors might be mentioned the importance of a design which will keep operating charges at a minimum; which will not introduce objectionable factors, such as noise; which will comply with code requirements, such as the non-increase of fire hazard; which will decide between street water and cooling towers, which will adapt the operation of the system to the building staff; which will decide on full automatic, partial or complete occupant control; allow for modifications to the building to prevent air leakage; prevent loss of heated air through ducts in winter, if a summer system only; the assurance of long life of moving parts in accordance with good mechanical practice; freedom from breakdown and uninterrupted service for any reason; and many others.

Another factor is the "unusual" job. Just when requirements are "unusual" in air conditioning is hard to say. This depends to no little extent upon the type of buyer and his attitude which means that for success those whims and desires of the purchaser which will be affected by the presence of the system and its results should be known beforehand by the designer. Those associated with the industry can all recall buyers who "wanted a little cooling—that's all" and who turned out to be the costliest type of individual to satisfy.

These concluding remarks are intended to summarize very briefly a few of those important factors which are involved in an air conditioning design, and which too often are not given due consideration. They also serve to suggest to the prospective purchaser of an air conditioning system some of the functions of the engineer who designs and specifies his system, and indicate the necessity of real engineering for every installation, whether large or small, so that the owner will get the right type of job—whether he knows all of the details involved in the right design or not.

Compact Piping Layout for Boiler Feed Pumps

By G. W. Hauck*

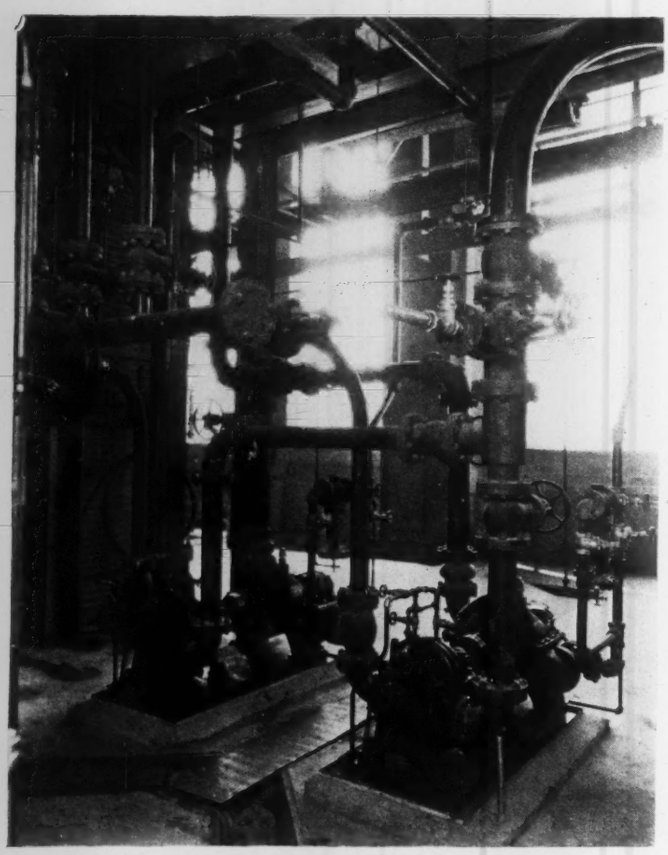


Fig. 1

THE photograph shows an installation of piping connecting two steam turbine driven boiler feed pumps supplying three boilers. This arrangement of the feed water piping has proved very convenient in operation. This boiler plant has three water tube boilers—two set in battery and one set singly and separated so that the stack and boiler feed pumps are located between the battery and single boiler, Fig. 2.

Fig. 3 indicates the details of the piping arrangement around the feed pumps. The compactness of the layout provides easy control of all lines because all of the operating valves are closely grouped and are within hand height of the floor, as shown by the general dimension of 6 ft, 6 in. from the floor line to the center of the boiler feed discharge header.

The steam and exhaust connections, the boiler feed suction and discharge lines to and from each pump, as well as the feed water discharge branches from the header to each of the three boilers, are easily and quickly controlled from a central point at the pumps. It should also be noted that the feed water suction line to the pumps can supply either hot water from the feed water heater or cold water from the cold water supply—again, valves at hand height from the floor control this operation.

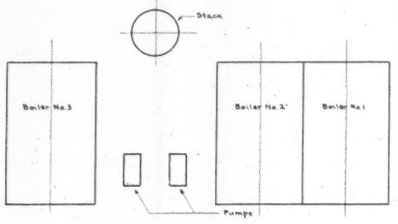
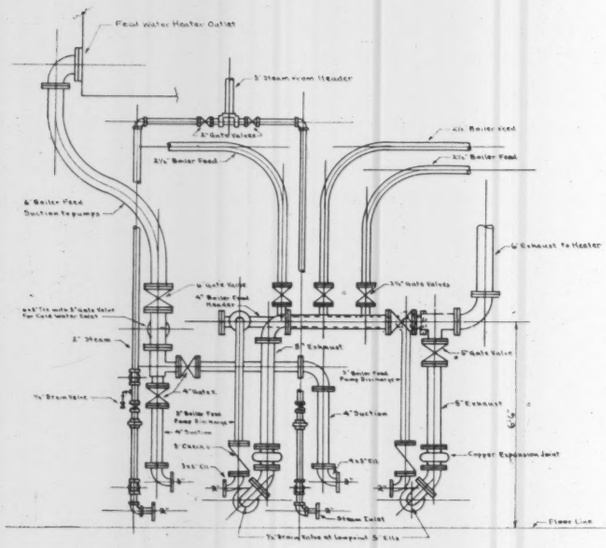


Fig. 2



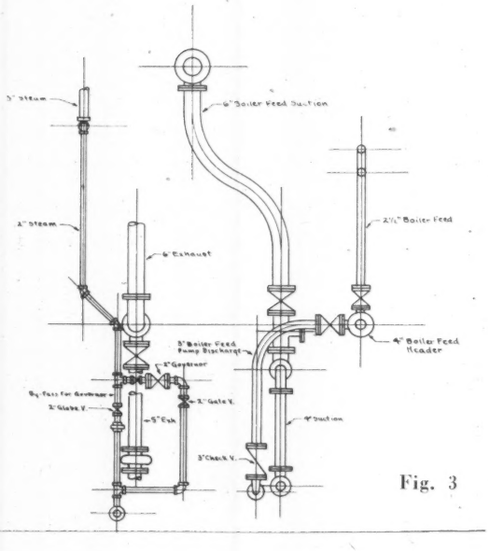


Fig. 3

*Engineer, Crane Co., Cincinnati, Ohio.

Heating·Piping
and Air Conditioning

American Society of Heating and Ventilating Engineers

JOURNAL SECTION

1895

DECEMBER 1935

Table of Contents

Performance of Fin-Tube Units for Air Heating, Cooling and Dehumidifying, by G. L. Tuve 589

Fuel Saving Resulting from the Use of Storm Windows and Doors, by A. P. Kratz and S. Konzo 595

Chicago Ready for the Meeting and Exposition 600

President's Message to Members 603

Nominations for 1936 604

Local Chapter Reports 605

Annual Reports of Local Chapters 609

Candidates for Membership 611

Candidates Elected 612

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Performance of Fin-Tube Units for Air Heating, Cooling and Dehumidifying

By G. L. Tuve[1] *(MEMBER)*, Cleveland, Ohio

This paper is the result of research conducted at Case School of Applied Science in cooperation with the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Introduction and Summary

SINCE presentation of the last report on this project[2], the work has consisted of about 250 one-hour test runs, and correlation of the results with data published by other investigators and with the performance tables issued by manufacturers of fin-tubing.

General conclusions are that, while there is now a fair knowledge of the laws of performance of fin-tubes, the data at present available to engineers are in some respects inconsistent. More study and research is necessary, especially in the field of dehumidification, in order to establish a satisfactory basis for uniform methods of rating these units. It would seem desirable for the A.S.H.V.E. to establish a simple and uniform method for testing any given design of extended surface unit, and to specify certain features in the developing of complete performance tables from such tests.

One simple method of establishing the ratings is suggested in this paper and the methods of applying it are discussed. Numerical results on the performance of a large number of coils are given, together with information on how the capacity of a coil changes when the operating conditions are changed. A table of typical performance values is recommended for use in estimating or checking the capacity of a fin-tube coil for any ordinary air-conditioning service.

Is There a Simple Way of Stating the Performance of a Fin-Tube Coil?

In the final practical application involving the selection of a coil for a given service, a complete performance table should be available for each working fluid, *i.e.*, steam, cold water, Freon, etc. Each table should show the change in performance due to changes in the velocity, temperature and humidity of the entering air, and due to changes in the number and arrangement of the tube elements. For hot or cold water circulation, the water velocity must also be taken into account.

But is there not some simple way of stating the basic performance factors for a given type of extended surface, so that the effect of changes in operating conditions may be readily calculated? Common practice among engineers answers this question by the almost universal use of the *overall coefficient* as the basis for general heat transfer calculations. Specialists in heat transfer analysis or testing must use the individual or surface coefficients in their calculations, but most engineers who select or specify heat transfer units will prefer to work from the overall coefficients. Such a viewpoint is justified in the case of multiple banks of fin tubes, because of the additional difficulty of separating out the performance of the individual rows or banks, and because of the complication of temperature gradients in the fins.[3] Moreover, it has been proven by experiment that under almost all conditions the simple exponential equation applies to the relation between the overall coefficient and the air velocity, *i.e.*, $U = \text{const.} \times V^n$. It will be noted that this is the equation of a straight line on logarithmic coordinates. The value of the coefficient for any and all air velocities can, therefore, be obtained if only one point and the slope of this line are known.

Makers and users of extended-surface units have gradually adopted the practice of using this straight-line relation on the logarithmic graph of capacity against air velocity, so that most performance tables are now built on this basis. But this relation could to advantage be more generally used by engineers, and it could well be used as a basis for establishing a standard method for testing and rating fin-tube coils.

To show the practical possibilities of this simple point-slope method of expressing fin-coil performance, the test results presented in this paper and the performance data quoted from other sources will be shown by this method. For all types and arrangements of coils, the performance at 500 fpm air velocity through the face area will be used as the basic point or reference value (symbol U_{500}) and the slope will be given (symbol n) for the straight line which shall be drawn through this point when it has been located on logarithmic coordinates.

Factors Affecting Fin-Coil Performance

Viewing the problem from this angle of fixing a point and then drawing a line of a given slope through this point, attention may be confined to two questions:

1. What factors determine the capacity of a fin-tube unit at the *standard* face velocity of 500 fpm.[4]
2. What factors determine the slope of the straight line (on logarithmic coordinates) showing the relation between coil capacity and face velocity of the air?

---

[1] Professor of Heat-Power Engineering, Case School of Applied Science.

[2] Heat Transfer from Direct and Extended Surfaces with Forced Air Circulation, G. L. Tuve and C. A. McKeeman, A. S. H. V. E. TRANSACTIONS, Vol. 40, 1934. See also *Heating, Piping and Air Conditioning*, June, 1934, p. 267.

For presentation at the 42nd Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Chicago, Ill., January, 1936.

[3] Basic heat transfer equations for fin-tubes were given and discussed in the former report on this research (see footnote [2]).

[4] This *standard* velocity is arbitrarily selected as representing a common value in practice. Any other value might be used if desired.

Fin-Coil Performance Tables

As already suggested, the *overall coefficient* (U or K), is the most convenient measure of the capacity of a fin-tube unit. This *specific capacity* is expressed in Btu per hour per square foot of air-side surface area per degree of temperature difference between the mean temperature of the air and that of the heating or cooling fluid. Table 1 gives values for the overall coefficient of several extended surface coils at 500 fpm face velocity. The items marked *research-tests* in Table 1 are the results of tests conducted by the author and his associates[5] at Case School of Applied Science, as a part of this research program. One of the test arrangements used in this work is shown in Fig. 1. The items marked *reported* are overall coefficients by test as reported by other investigators (see references), and the items marked *commercial* are taken from manufacturers' bulletins. Knowing the performance at one air velocity, the coefficient at any other velocity may be obtained by drawing a straight line through the given point on a logarithmic plot of overall coefficient against air velocity. Table 1 also gives the slope of such a line for each case, *i.e.*, the value of n in the equation:

$$U = C\,V^n, \text{ or } U_1/U_2 = (V_1/V_2)^n$$

The value of the slope n may readily be calculated from any performance table, even when the coil dimensions are not given and the overall coefficient cannot be calculated. Table 2 gives additional values of n for various types of forced-convection units.

Tables 1 and 2 summarize most of the specific data on overall heat transfer coefficients of fin-tube units which are at present available to American engineers.

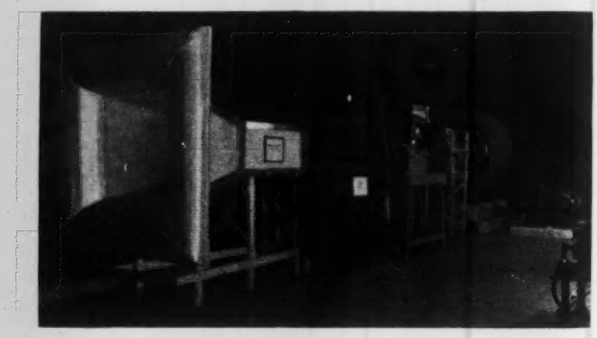


Fig. 1—General arrangement of test duct showing a single-row coil under test and electric boiler with automatic control

Table 3 presents a list of the methods by which the overall coefficient may be increased.

Table 4 presents a list of the methods by which the slope of the capacity-velocity curve may be increased.

It should be noted that many of the factors affecting the performance of fin-tube sections as listed in Tables 3 and 4 are dependent on natural physical laws only, and are independent of the design or proportions used by the manufacturer. (These factors were discussed at some length in the June, 1934, paper on this research, see footnote [2].) The effect of such factors on coil performance should be determined by research and be made common property. After the laws have been determined, they should be applied in a uniform manner according to a Test Code, so that the performance of surface coils can be more accurately specified and understood by engineers generally. The results of this research project to date have demonstrated that if there is a good bond between fin and tube, the rather narrow differences in design proportions at present used by manufacturers of circular fin-tubes do not make a great deal of difference in heat transfer coefficients compared with the differences which are due to operating conditions.

Table 5 gives recommended typical overall heat transfer coefficients for finned sections operating under various common conditions, and these values are shown graphically on rectangular coordinates in Fig. 2.

Questions to be Answered by Research

Assume that a typical section of a certain design has been tested according to a standard method (say with low

Table 1—Performance of 25 Types of Copper Circular-Fin-Tube Units

(Dipped metal bond or integral fins)

No.	Data Source	Working Fluid	No. of Rows	In-Line or Staggered	Tube Diam. In.	O.D. Fins In.	Fins per In.	Free Area %	U at 500 fpm	n Slope of Line
AIR HEATING SERVICE										
1	Reported[a]	Steam, 2-100 lb	4	Stag.	0.375	0.87	6	57	13.0	0.62
2	Research-Tests	Steam, 2 lb gage	2	Line	0.625	1.37	7	42	10.8	0.61
3	Commercial	Steam, 5-150 lb	1-6	Stag.	0.625	1.44	8	50	10.7	0.52
4	Commercial	Steam, 5-150 lb	1-6	Stag.	0.625	1.37	7	50	10.5	0.57
5	Commercial	Steam, 5-100 lb	1-6		0.625		7		10.5	0.60
6	Research-Tests	Steam, 5 lb gage	4	Stag.	0.625	1.47	7	53	10.5	0.65
7	Commercial	Steam, 5-150 lb	1	Cast Iron Sections				44	10.2	0.62
8	Research-Tests	Steam, 2 lb gage	2	Line	0.625	1.12	6	37	10.1	0.55
9	Research-Tests	Steam, 5 lb gage	1		0.625	1.47	7	52	9.3	0.52
10	Research-Tests	Steam, 5 lb gage	1		0.625	1.37	7	56	9.1	0.49
11	Commercial	Steam, 5-150 lb	6	Cast Iron Sections				44	9.1	0.62
12	Research-Tests	Steam, 2 lb gage	1		0.625	1.37	7	49	9.0	0.48
13	Research-Tests	Steam, 2 lb gage	1		0.625	1.12	6	37	9.0	0.46
14	Commercial	Steam, 5 lb gage	1	Cast Iron Sections					7.0	0.50
15	Commercial	Steam, 5 lb gage	6	Cast Iron Sections					6.5	0.60
AIR COOLING WITHOUT DEHUMIDIFICATION										
16	Commercial	Water, 2 fps	1-6	Stag.	0.625	1.37	7	50	8.9	0.47
17	Commercial	Water, 2 fps	1-6	Stag.	0.625	1.44	8	50	8.6	0.45
18	Reported[b]	Water, 2 fps			0.625	1.44	8	50	8.5	
19	Research-Tests	Water, 2 fps	2	Stag.	0.75	1.75	7	55	7.2	0.45
20	Research-Tests	Water, 2 fps	6	Stag.	0.75	1.75	7	55	7.1	0.64
21	Commercial	Direct Expansion	1		0.75	1.62	4–6		5.8	0.62
22	Commercial	Direct Expansion	6		0.75	1.62	4–6		4.7	0.61
23	Research-Tests	Direct Expansion	4	Stag.	0.75	1.75	7	55	6.2	0.51
AIR COOLING AND DEHUMIDIFICATION (Approximate Only)										
24	Research-Tests	Water, 2 fps	4	Stag.	0.75	1.75	7	55	14.8	0.81
25	Commercial	Direct Expansion	4	Stag.	0.625	1.44	8	50	16.0	0.51

[a] Fellows and Stewart, Tests on an Industrial Heater, *Heating and Ventilating*, July, 1935, p. 36. The very high coefficient in this case is probably due to the extreme turbulence caused by the blow-through fan.

[b] Computed from data given in Rational Development and Rating of Extended Air Cooling Surface, H. B. Pownall, *Refrigerating Engineering*, Oct. 1935, p. 211.

[5] Prof. F. H. Vose, Head of the Mechanical Engineering Department, has encouraged this cooperative research and made the facilities of the Department available for carrying it on. Professors A. O. Willey and C. A. McKeeman have given generously of their time and effort to the work. Much credit is due to V. T. Kartorie, Assistant in Mechanical Engineering 1933-35, who submitted a thesis for a Master's Degree on the basis of his experimental work on this project. Messrs. D. E. Wise, W. B. Rust and P. Borkat have each had an important share in this research over the past two years, and have submitted undergraduate theses based on their work.

Table 2—Additional Data on Effect of Air Velocity on Heat Transfer Coefficient

(As Stated in Commercial Bulletins)

Type No.	Working Fluid	No. of Rows	Type of Unit	n = Slope of Capacity-Velocity Curve (Log Plot)
26	Steam, 2 lb gage		Fin-Tube Unit Heater	0.66
27	Steam, 5 lb gage		Fin-Tube Unit Heater	0.68
28	Steam, Any Press.	1-6	Fin-Tube Blast Coils, 7-8 Fins/in.	0.57
29	Steam, Any Press.	1-6	Fin-Tube Blast Coils, 7-8 Fins/in.	0.55
30	Steam, 5 lb gage	1-6	Blast Coils, Continuous Fin	0.53
31	Steam, 2 lb gage	6	Blast Coils, Continuous Fin	0.51
31	Steam, 2 lb gage	1	Blast Coils, Continuous Fin	0.46
32	Steam, 5 lb gage	5	Blast Coils, C.I. with Fins	0.60
32	Steam, 5 lb gage	1	Blast Coils, C.I. with Fins	0.50
33	Steam, 5 lb gage	1	Blast Coils, C.I. no Fins	0.62
33	Steam, 5 lb gage	6	Blast Coils, C.I. no Fins	0.58
34	Dir. Exp. Refrig.	1-6	Cooling Coils, Continuous Fin	0.25
34	Water, 0.75 fps	1-6	Cooling Coils, Continuous Fin	0.24
35	Water or Brine, 1 fps	Any	Cooling Coils, Continuous Fin	0.51
35	Dir. Exp. Refrig.	Any	Cooling Coils, Continuous Fin	0.51
36	Water, 1-4 fps	Any	Cooling Coils, Continuous Fin	0.29

pressure steam), and the values of U_{500} and n have been determined as already suggested. It would be desirable if tables could then be built to give the performance of a similar section with any number of rows of tubes, or operating under any typical condition of heating, cooling or dehumidifying. To so convert the performance under one set of conditions to that under another set of conditions will require that answers to the following questions be known:

1. What is the effect of increasing or decreasing the number of tube rows, i.e., changing the depth of the coil?
2. What is the effect on the capacity of a coil if staggered tube arrangement is used, as compared with in-line arrangement?
3. For round-fin tubes, what is the effect of changing the center distance of the tubes in one row, or of changing the distance between rows?
4. What is the effect of changing the coil service from heating to cooling or vice versa?
5. When a liquid is used in the tubes (water or brine), how does changing the liquid velocity change the overall coil performance?
6. How is coil performance affected by the nature of the fluid used in the tubes, i.e., steam, hot water, cold water, Freon, etc.
7. How can the dehumidifying performance at various humidities be predicted from the dry-coil performance?

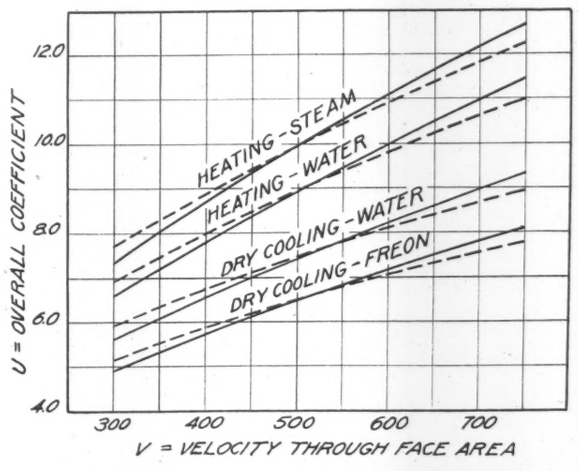


Fig. 2—Graphical representation of recommended values for dry-coil coefficients. Use dotted lines for one-and two-row sections. Use solid lines for four or more rows

Table 3—Methods for Increasing the Overall Coefficient U for a Given Fin-Tube Unit in a Constant-Velocity Air Stream

Type of Service	Fluid in Tubes	Methods for Increasing U at Constant Air Velocity
Any	Any	Placing an eddy- or turbulence-grid in front of the first row of tubes.
Any	Any	Using staggered tube arrangement (in place of In-line arrangement) to produce air turbulence.
Any	Any	Corrugating the fins or setting the fins in successive rows at different angles to produce turbulence.
Any	Any	Reducing free-open area by increasing the number of fins or the number of tubes or both.
Any	Any	Reducing the diameter of the tubes or the overall diameter of round fins (same surface area).
Any	Any	Increasing the fin thickness above the minimum now commonly used.
Any	Hot or Cold Water or Brine	Increasing the velocity of the liquid in the tubes.
Dehumidification	Any	Lowering the coil temperature or raising the dewpoint of the entering air.

Table 4—Methods for Increasing the Velocity Effect or the Slope n of the Capacity-Velocity Curve

Type of Service	Fluid in Tubes	Methods for Increasing n, the Slope of the Capacity-Velocity Curve
Any	Any	Placing an eddy-or turbulence-grid in front of the first row of tubes.
Any	Any	Using staggered tube arrangement (in place of in-line arrangement) to produce air turbulence.
Any	Any	Corrugating the fins or setting the fins in successive rows at different angles to produce turbulence.
Any	Any	Increasing the number of rows or banks of tubes.
Any	Any	Reducing the ratio of fin surface to prime tube surface.
Any	Any	Increasing the fin thickness above the minimum now commonly used.
Any	Hot or Cold Water or Brine	Increasing the velocity of the liquid in the tubes.

Table 5—Typical Values of U_{500} and n Recommended for Use in Estimating or Checking

The following values apply to typical American fin-tubes having 4 to 8 fins per inch, on ½ in. to 1 in. tubing, with metal bond between tube and fin, and for face velocities from 200 to 1000 fpm.

U_{500} = overall coefficient, Btu per sq ft per hr per degree, at 500 fpm face or approach velocity, and based on logarithmic mean temperature difference between air and fluid in tubes.

n = slope of the straight line through U_{500} when overall coefficient is plotted against face velocity on logarithmic coordinates = value of n in the equation: $U_1/U_2 = (V_1/V_2)^n$

It is usual practice to assume the same overall coefficient for any temperature of the entering air (heating or dry cooling), and for any coil temperature.

U_{500}		n			
1 or 2 rows	4 or more rows	1 or 2 rows	4 or more rows	Service	Fluid in Tubes
10.0	10.0	0.50	0.60	Heating	Steam, 1 to 100 lb gage
9.0	9.0	0.50	0.60	Heating	Hot water, 140 deg to 250 deg, 2 to 4 fps
7.5	7.5	0.45	0.55	Dry Cooling	Cold water, 35 deg to 70 deg, 2 to 4 fps
6.5	6.5	0.45	0.55	Dry Cooling	Direct expansion Freon. (Approximate for other refrigerants)
15.0*	15.0*	0.7	0.7	Dehumidifying	Cold water, 35 deg to 55 deg, 2 to 4 fps
13.0*	13.0*	0.7	0.7	Dehumidifying	Direct expansion Freon.

*Values for dehumidifying are based on wet-bulb mean temperature differences, *not* dry-bulb. This method should be used with caution, as it does not show the dry-bulb temperature changes.

The answers to these questions depend on physical phenomena, and have very little connection with the particular design used by one manufacturer or another.

These questions will now be discussed in turn, and data presented which has been obtained in this research. An effort will also be made to correlate data from other sources which bears on the answers to the same questions.

Questions 1 and 2. Staggered Arrangement and Depth of Coil. Increasing the number of tube-rows and staggering the tubes are two of the several methods for increasing the local air turbulence or eddying to which the coil surfaces are exposed (see Tables 3 and 4). Several investigations have demonstrated that the effect of increased turbulence is to increase both the overall coefficient U at a given air velocity and the slope n of the capacity-velocity curve. The increase in heat transfer cannot be stated as a simple percentage, in fact the capacity-velocity curves may cross as in Fig. 3, which is a typical group of curves plotted from tests on 1-row to 6-row depth of section. It will be noted that the 6-row section is the most effective when the air velocity is high, but that the 2-row section gives a slightly higher coefficient when the velocity is very low. This relation has been confirmed by tests on three types of units, and for both heating and cooling. Certain manufacturers at present use the same coefficient for any number of rows of tubes (see Units 3, 4, 16, and 17, Table 1), and several manufacturers use the same value of the slope, irrespective of the depth of section. These practices are contrary to the results of repeated tests in this research.

The effect of staggering fin-tubes is probably less than that for plain tubes, but most of the published data and photographs on the advantages of staggered tube arrangement are from the results of German investigators on banks of plain tubes. Pownall[6] gives data indicating an increase of about 11 percent in overall coefficient at approximately 400 fpm face velocity, but the number of tube rows is not stated. Results obtained by the author on a 2-row unit with close tube centers showed only 5 percent more heat transfer when the tubes were staggered, while a disturber-grid placed in front of the section increased its capacity 16 percent. The increase in capacity due to staggered tube arrangement, compared with in-line arrangement, is, of course, greater as the depth of the coil is increased, and it is more important with high velocities and wide tube spacings, probably reaching about 15 percent in some cases.

The most important loss in heat transfer due to lack of air turbulence is in the first or upstream row of tubes which receives the undisturbed air stream, and this condition is, of course, not improved by staggering the tubes. Fig. 4 gives the results of tests on a 2-row unit in which each row was tested separately and then the two rows tested together, with tubes in line. In this case the heat transfer from the second row alone was more than one-third greater than that from the first row. It has been demonstrated repeatedly in this research that the effectiveness of the first row may be brought up to that of the others by the use of a disturber-grid placed in front of the section (see data in June, 1934, paper).

Question 3. Relation of Free Area to Gross Face Area. In general, the smaller the free area for a given face area, the higher will be the heat transfer coefficient. This is because the heat transfer is dependent upon the velocity *at the surface,* and the latter is comparable to the velocity through the free-open area. There are, of course, prac-

[6]Rational Development and Rating of Extended Air Cooling Surface, H. P. Pownall, *Refrigerating Engineering,* October, 1935, pp. 211-218.

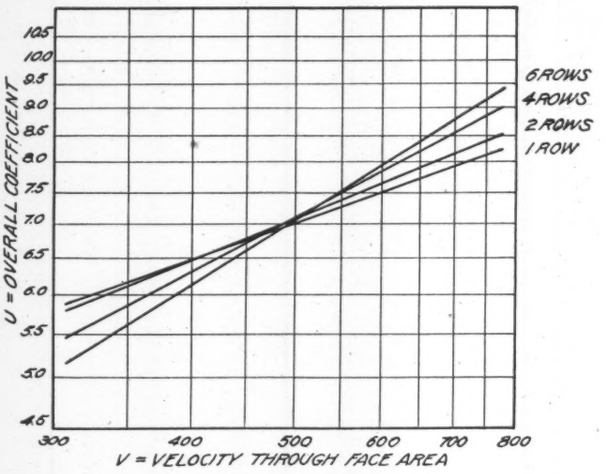


Fig. 3—Typical overall coefficients for one-row to six-row depth section, (logarithmic coordinates)

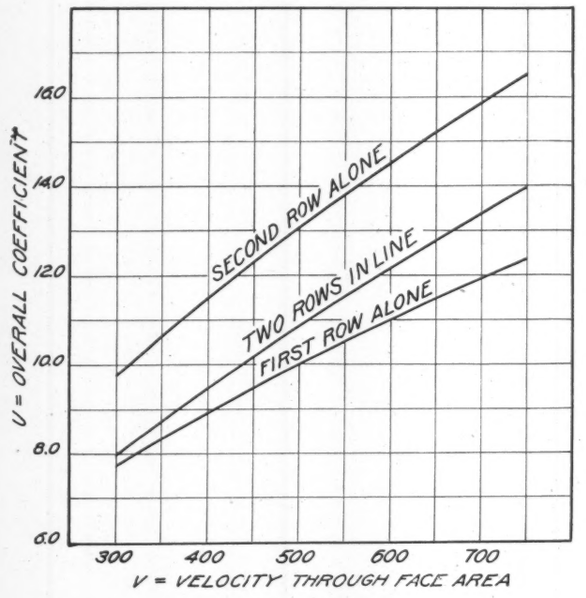


Fig. 4—Curves showing low effectiveness of first or upstream row of fin-tubing as compared with second row

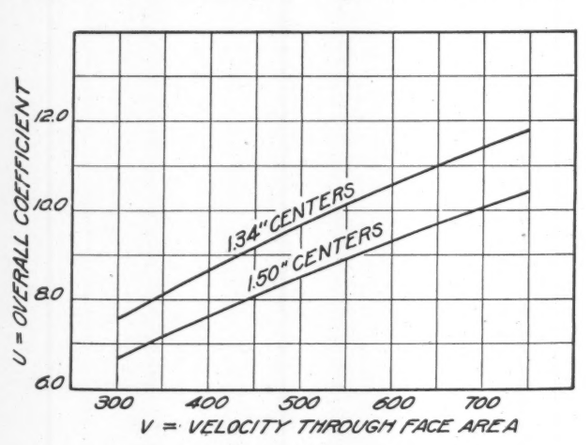


Fig. 5—Results of tests on single-row sections with different spacings of fin-tubes

tical limits to the reduction of free area, mainly those of air resistance and air noise, and hence the range of *percentage free area* used in practice is rather small, (see Table 1).

Fig. 4 shows the results of two tests on identical 1⅜ in. o. d. fin-tubing spaced on 1.50 in. centers in one case and on 1.33 in. centers in the other. This is only a small difference in spacing, but it demonstrates that a coil is more effective if the fin-tubes are closely spaced. This is true even when comparing two points representing the same velocity through the free area. In general the best spacing is probably that which places the fins as close together as is possible without interlocking.

Question 4. Heating and Cooling Service from the Same Coil. The difficulty of comparing the heat transfer coefficients for heating and cooling is that several other conditions are also changed when the direction of heat flow is reversed. Cooling is carried out at a lower temperature level and with a smaller temperature difference than heating. Cooling fluids usually show a lower surface coefficient (inside the tubes) than is obtained with steam or hot water. These differences all tend toward a lower overall coefficient for cooling coils (see Tables 1 and 5). There are some inconsistencies in commercial practice, regarding capacities of the same coil for heating and cooling, as is shown by the fact that one manufacturer uses the same overall coefficients for heating with steam and for cooling with water (high water velocity), while another shows a 30 percent difference between the two.

Experiments are now in progress as a part of this research, in which, for instance, 80 deg air is first cooled with 40 deg water and then heated with 120 deg water, all other conditions remaining constant.

Question 5. Effect of Liquid Velocity in Tubes. Low liquid velocity means a low coefficient U and a lower value of the capacity-velocity slope n. This is because of the high resistance to heat flow offered by the thicker viscous film of liquid at the inside tube wall when the average velocity of the liquid is reduced. The magnitude of this effect depends on the viscosity of the liquid and on the tube diameter.

There is both a rapid decrease in heat transfer and a rapid increase in friction coefficient when the Reynolds number of the liquid flow is so low that the flow changes from turbulent to viscous in character. Hence it would seem to be poor practice to operate coils with viscous flow in the tubes. To avoid the viscous region, liquid velocities in cooling coils should be well above 1 fps for water and above 2 fps for brine. For smaller tubes than ⅝ in. even higher velocities are necessary. For heating coils, on the other hand, the low limit of velocities usually depends on the allowable temperature drop of the water rather than on the encountering of viscous flow. This is because the viscosity of 160 deg water is only one-fourth as great as that of 40 deg water.

For strict accuracy the corrections for water velocity should be based on test data which give both liquid-side and air-side coefficients. To obtain such data requires a large amount of testing, however, and the corrections may be made by the simple method of changing U_{500} and n. The following example shows a method of computing the corrections. The calculated correction factors are given in Table 6. The equation for U in terms of the individual liquid-side coefficient h_1 and the air-side coefficient h_a is

$$U = \frac{1}{\frac{R}{h_1} + \frac{1}{xh_a}}$$

where x is a factor to account for temperature gradient in the fins as suggested by Pownall[7] and R is the ratio of air-side surface area to liquid-side surface[8] area.

Typical values for substitution in this equation are: $R = 10$. $h_1 = 210\ V_1^{0.80}$, where V is the average liquid velocity in feet per second, and $xh_a = 0.202\ V_a^{0.65}$, where h_a is air velocity in feet per minute through the face area. The resulting correction factors based on a water velocity of 2 fps as unity, are shown in Table 6. For comparison the values given by three manufacturers of fin-tubing are included in the same table. Certain differences between the calculated correction factors and those based on commercial data are at once apparent. One error in the computation method is the assumption that x, the correction for fin temperature gradient, varies with air velocity and does not change with water velocity, but this error should be very small. Tests on this phase of the subject are as yet incomplete, but Table 6 shows the need for additional research data, and the tests are being continued.

Question 6. Effect of Changing the Fluid in the Tubes. More data is needed on surface coefficients for the fluids inside the tubes. Work is now in progress in this research on direct-expansion of Freon (see Fig. 6). The ordinary range of inside surface coefficients for steam, direct expansion refrigerants and water (above critical velocity) is probably from 250 to 1200. The coefficient should be higher for steam, but difficulties in securing adequate venting of air and uniform distribution to all tubes are often great. Pownall suggests a value of 300 for Freon and gives a range of 350 for cold water at 2 fps to 1200 at 6 fps.

The effect of a change from 250 to 1200 is to change the overall coefficient from 7.1 to 9.2 in a typical case in which the surface area-ratio is 10 and the air-side coefficient (including temperature gradient factor) is assumed constant at a value of 10, at a face velocity of 500 fpm. Thus the overall coefficient is changed only 30 per cent when the inside surface coefficient is increased almost 500 per cent. If a reasonably accurate set of inside surface coefficients were available, an accurate set of correction factors could be set up so that a coil could

Table 6—Comparison of Water-Velocity Correction Factors for Cooling Coils

	Value of U_{500}	Correction U_{500}	Value of n	Correction for Factor n
1. *Calculated example*				
Water vel. 2 fps	8.67	1.00	0.50	1.00
Water vel. 4 fps	9.66	1.11	0.55	1.11
Water vel. 6 fps	10.10	1.16	0.57	1.14
2. *Commercial data No. 1*				
Water vel. 2 fps	8.90	1.00	0.47	1.00
Water vel. 4 fps	9.75	1.10	0.50	1.06
Water vel. 6 fps	10.35	1.16	0.53	1.13
3. *Commercial data No. 2*				
Water vel. 2 fps	....	1.00	0.51	1.00
Water vel. 4 fps	....	1.01	0.51	1.00
Water vel. 6 fps	....	1.01	0.51	1.00
4. *Commercial data No. 3*				
Water vel. 2 fps	....	1.00	0.24	1.00
Water vel. 4 fps	....	1.04	0.24	1.00

[7]Loc. cit.
[8]The above equation is Eq. 2, in the 1934 report, see footnote [2].

be tested with steam and its capacity with all the other heating and cooling fluids calculated therefrom.

Question 7. Dehumidifying Coils. When a coil is used for dehumidifying, its capacity, based on dry-bulb temperature, is very much increased as compared with

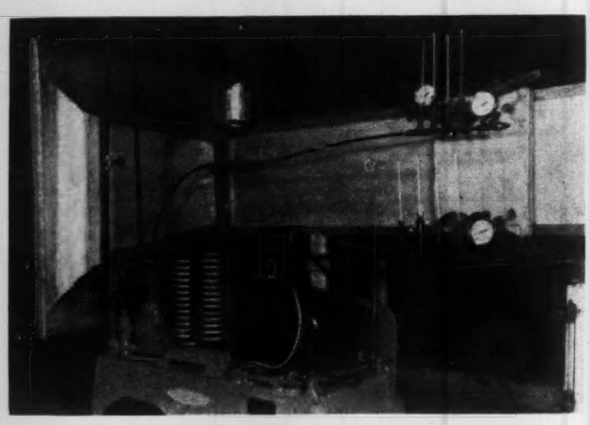


Fig. 6—Working section of test duct with four row "Freon" coil under test

dry-cooling only, but it is difficult to show this increase by any simple method.

It will be noted from the discussion of dry-coil performance that there are at least 10 variables affecting the value of the overall coefficient, but that a few straight-line graphs against one variable, the air velocity, will serve to represent most of the common cases. The presence of dehumidification not merely adds another variable, but it adds an entire heat transfer process, *viz.*, the condensation of a vapor. This process in turn is sensitive to most of the variable conditions which affect dry cooling. In addition, it is one of the most complex of the heat transfer processes, as is shown by the current arguments regarding drop-condensation and film-condensation. Since surface heat transfer coefficients for condensation are very much greater than gas-to-surface coefficients, it is to be expected that the overall coefficient would be much increased when condensation is present, even though the two processes interfere with each other.

Methods for obtaining the performance of a dehumidifying coil have been given by Scanlan, Ruppricht, Schmidt, Knaus, King, Pownall and others,[9] and only the briefest summary can be given here. Four general viewpoints may be mentioned:

1. Since a theoretical relation exists between the surface coefficient for dry cooling and the combined coefficient for cooling and dehumidifying, the latter may be calculated from the former by means of this theoretical formula, modified by an empirical correction factor. This equation and correction factor may, if desired, be embodied in a graphical solution on the psychrometric chart.

2. The combined coefficient for cooling and dehumidification is a function of the ratio of dehumidification load to total load, and may be calculated from the dry-coil coefficient as soon as this ratio is known.

3. Dehumidification may be considered as a process separate from sensible cooling, and the coil capacity for the two calculated independently, using two separate sets of coefficients or one coefficient and a correction factor. While sensible heat removal depends on the dry-bulb mean temperature difference, latent heat removal depends on the dew-point mean temperature difference.

4. Since the wet-bulb temperature is the index of the total heat of air, the reduction of this total heat may be calculated on the basis of wet-bulb mean temperature differences and the overall coefficients based thereon, without regard for dry-bulb or dew-point temperatures.

At present there is apparently not enough research data available to establish full confidence in any one of these methods.

About 50 two-hour dehumidifying tests have been made as a part of this research, and the results have been examined according to each of the methods stated above. The conclusion is that the data are incomplete as yet, but indications are that the simple point-slope method used herein for expressing dry-coil performance may also be used for dehumidifying coils (method No. 4, previously mentioned), if its limitations are recognized. There has been included in Table 1 the most readily available data on U_{500} and n from these research tests and from commercial sources. U in this case is the combined overall coefficient for both sensible and latent heat, and it is based on wet-bulb logarithmic mean temperature differences. An important defect of this method is that it does not separate the latent and sensible heat loads, and absurd results may be obtained if the method is not properly used.

A satisfactory treatment of dehumidification would require an entire paper, but much additional experimental work should first be done and the results made available in a form which will permit general conclusions to be drawn.

Conclusions

Tests on fin-tube coils indicate that reasonably accurate performance tables may be built on the basis of a few simple straight-line graphs of overall heat transfer coefficient plotted against air velocity. These graphs may readily be plotted (on logarithmic coordinates) by locating the value of the coefficient at 500 fpm air velocity, and then drawing a line of given slope, as shown by Tables 1 and 5. This same method provides a means for obtaining the capacity of a unit at any operating condition when the capacity at another operating condition is known. For rapid approximate calculations, the capacity of a heating or a dry-cooling coil may be assumed to vary directly as the square root of the air velocity.

Any arrangement which increases the local eddies in the air stream will increase heat transfer, especially at the high velocities. For maximum heat transfer the fin tubes should be placed as close together as is possible without interlocking, arranged in staggered rows, and provided with a turbulence-grid in front of the section to increase the effectiveness of the first row of tubes.

Certain basic data on the performance of fin-tube coils are still incomplete. Accurate knowledge of surface coefficients for the fluids inside the tubes is lacking, and a thorough study should be made of the various methods which have been suggested for showing the performance of a coil in dehumidification.

By additional research along these lines it should be possible to develop in the near future a test code and a set of rules by which the performance of any type of heat transfer surface may be calculated, for any case of heating, cooling or dehumidifying, from a few tests made under specified simple conditions. Such a procedure would place the selection of extended surface coils upon a uniform basis and give engineers more confidence in being able to produce the results called for in their specifications.

[9]See references in Rational Development and Rating of Extended Air Cooling Surface, H. B. Pownall, *Refrigerating Engineering*, October, 1935.

Fuel Saving Resulting from the Use of Storm Windows and Doors

By **A. P. Kratz*** **and S. Konzo†** ***(MEMBERS)***
Urbana, Ill.

Object

THE object of this investigation was to determine, under actual service over a wide range in weather conditions, the saving in fuel that could be effected by equipping a typical residence with storm windows and doors; and to compare the actual saving so effected with the saving computed from heat loss calculations employing commonly accepted values for the coefficients of heat transmission and air infiltration.

Description of Research Residence and Heating Plant

The Research Residence and heating plant have been completely described in previous publications.[1] The Research Residence, shown in Fig. 1, is a three-story struc-

Fig. 1—Warm Air Research Residence, Urbana, Ill.

ture of standard frame construction. The wall section consists of weather boarding, building paper, sheathing, 6-in. studding, wood lath, and plaster with rough sand finish. The walls are not insulated and no weatherstripping is used at the windows and doors.

The total space heated during these tests consisted of three rooms, a sun parlor, a breakfast nook, and a hallway on the first story; three rooms, a bath room, and a hallway on the second story; and two rooms, a bathroom, and a hallway on the third story. The total volume of this heated space, from which the basement was excluded, was approximately 17,540 cu ft. The calculated heat loss was approximately 137,500 Btu per hour at an indoor-outdoor temperature difference of 80 F. The Research Residence is completely furnished, and during the heating season it was occupied by four people.

The heating plant consisted of a coal fired furnace used in connection with a forced-air heating system. Three cold air returns were used which were connected into a cold-air box above the inlet to a centrifugal type of fan. The furnace was placed at the East end of the basement, and the warm air registers were served from two main trunk systems. The furnace was of the cast-iron, circular-radiator type, having a 24-in. firepot and 20-in. grate, and was equipped with a casing 42 in. in diameter.

The control[2] of the heating plant was accomplished by means of a room thermostat operating to open and close the ash pit damper and to start and stop the fan. This room thermostat was used in conjunction with two bonnet thermostats which served as high and low limit controls for the temperature of the air in the furnace bonnet. The room thermostat was located on an inside wall of the dining room at a height of 5 ft from the floor and was adjusted to maintain an air temperature of approximately 71 F at this level in all of the rooms of the Residence.

One series of tests was run with the Residence equipped with storm windows and door, and one series was run without such equipment. For the first mentioned series, all of the windows on the three stories of the Residence, with the exception of two small quarter-round windows in the east dormitory, were provided with tightly fitting storm sash. As shown in Fig. 2, felt stripping was placed along all four contact edges and the storm sash was clamped tightly to the window casing by means of screws. One window in each of the second story rooms was fitted with hinges at the top so that outdoor air could be admitted occasionally if desirable. The front entrance was equipped with a storm

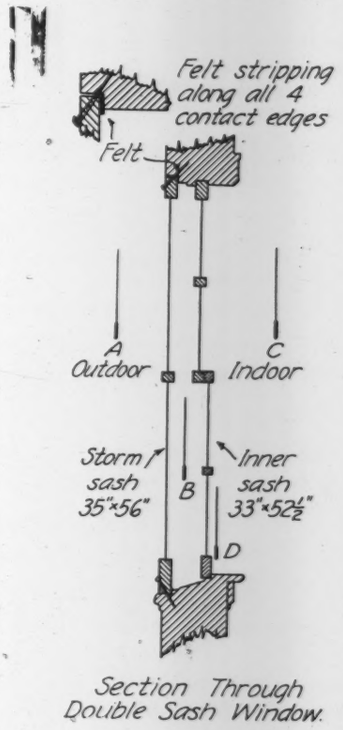


Fig. 2—Line diagram showing method of installing storm sash

*Research Professor, Engrg. Experiment Station, University of Illinois.
†Special Research Associate, Engrg. Experiment Station, University of Illinois.

[1]University of Illinois, Engrg. Experiment Station, *Bulletins Nos. 189, 246,* and *266.* Also Study of Summer Cooling in the Research Residence at the University of Illinois, by A. P. Kratz and S. Konzo, A.S.H.V.E. TRANSACTIONS, Vol. 39, 1933.

For presentation at the 42nd Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Chicago, Ill., January, 1936.

[2]Control Type IV described in the paper, Automatic Controls for Forced-Air Heating Systems, by S. Konzo and A. F. Hubbard, A.S.H.V.E. TRANSACTIONS, Vol. 40, 1934.

door, but the rear entrance was not. The outside door at the rear opened into a vestibule which contained the basement steps, and the kitchen door opened into this vestibule. Hence an additional storm door was not considered necessary. The areas of window and door openings, of wall surfaces, and the ratios of openings to wall surfaces are given in Table 1.

Method of Conducting Tests

The two series of tests selected to determine the effect of storm windows and doors comprised part of the routine test program carried on at the Research Residence. The same test methods were employed for all such tests. The fuel burned was anthracite, having a calorific value of 13,175 Btu per pound, and the controlling thermostat was adjusted to maintain a temperature of approximately 71 F at the 5-ft level in all rooms. This temperature was maintained during all of the 24 hours of the day.

The furnace was fired at four regular periods, namely 7:00 a.m.; 11:00 a.m.; 4:00 p.m.; and 10:00 p.m., and a record was made of the net fuel consumed during each 24-hour period. Either periodic or continuous records were made of all significant temperatures, and average daily temperatures both indoors and outdoors were obtained from these records. Each series of tests was continued over periods of sufficient length to obtain a wide range of weather conditions representative of the heating season.

Results of Tests

Infiltration. No provision was made for the continuous introduction of outdoor air. Therefore, the only infiltration that occurred was that due to leakage around the window and door frames, leakage through the frame walls, and the influx of cold air accompanying the opening of outside doors. During ordinary conditions with normal occupancy by four persons, the slight inleakage of air that occurred was sufficient to prevent any noticeable accumulation of odors. Occasionally it was found desirable to remove the cooking odors from the kitchen by opening the door to the outdoors for a few minutes. It should be noted in this connection that the outdoor air requirements to prevent accumulation of odors are comparatively small for residence service, and it is questionable whether in the ordinary residence installation, special provision for continuous introduction of outdoor air would be necessary. Any such special ventilation would, of course, partly offset the heat saving that could be accomplished by the application of tightly fitting storm sash.

Table 1—Data on Window and Wall Surfaces

1.	Number of window openings	50
2.	Number of windows equipped with storm sash	48
3.	Number of door openings to outdoors	2
4.	Number of storm doors	1
5.	Area of exposed window openings, square feet	525
6.	Area of windows equipped with storm sash, square feet	522
7.	Area of exposed door, square feet	24.5
8.	Area of double door, square feet	24.5
9.	Gross area of exposed structure, square feet	3004.5
10.	Net area of exposed wall (windows and doors excluded), square feet	2455
11.	Ratio of storm windows and doors to total exposed openings, per cent	99.4
12.	Ratio of total exposed openings to gross wall, per cent	18.3
13.	Ratio of total exposed openings to net wall, per cent	22.4

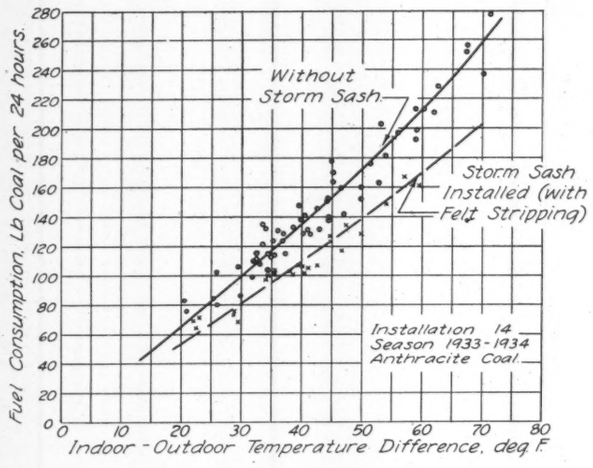

Fuel Consumption, Lb Coal per 24 hours
Indoor - Outdoor Temperature Difference, deg F
Without Storm Sash
Storm Sash Installed (with Felt Stripping)
Installation 14
Season 1933-1934
Anthracite Coal

Fig. 3—Fuel consumption with and without storm sash

Comparison of Fuel Consumption. The data on the amount of fuel required to operate the Research Residence with and without storm windows and doors are shown in Fig. 3, in which the daily fuel consumption, in pounds of coal, is plotted against the difference in temperature between the indoors and outdoors. The deviations of the points from the mean curve are primarily caused by differences in daily fuel consumption brought about by variable wind and sun effects, which cannot be represented on a curve in which the abscissa is temperature difference alone. However, the deviations resulting from wind and sun effects tend to compensate when a number of tests are conducted with the same indoor-outdoor temperature difference, and the mean curve becomes representative of the actual fuel consumption when considered from the standpoint of the season as a whole.

The curves in Fig. 3 show that the average daily amount of fuel required to heat the Residence when the outdoor temperature was 40 F, which corresponds closely to the mean seasonal temperature in Urbana, Ill., was 100 lb when storm doors and windows were not used and 81 lb when storm doors and windows were used. This represents a saving in fuel consumption of 19 per cent attributable to storm doors and windows. The saving in milder weather was somewhat less, but in severer weather the saving increased to a value of 21 per cent shown for zero weather, or at an indoor-outdoor temperature difference of 70 F. The results therefore indicate that a saving of approximately 20 per cent in the seasonal fuel consumption could be reasonably attributed to the installation of storm doors and windows on the Research Residence.

Calculated Reduction in Heat Losses. The calculated reduction in heat losses was obtained by computing the heat losses from the structure both with and without storm windows and doors. The difference between the two calculated values would be accounted for in the items involving infiltration and heat transmission through windows and doors. These items were therefore calculated for a zero day, or for an indoor-outdoor temperature difference of 70 F, and added to the basic heat loss of 73,770 Btu per hour, which took place through walls, ceilings, floors and all parts of the structure exclusive of the exposed windows and the front door. The data used for the calculation of the infiltration and heat trans-

Table 2—Heat Loss Data, Based on 70 F Temperature Difference

No.	Item	Without Storm Sash	With Storm Sash
1.	Heat loss through walls, floors, and ceilings, Btu per hour	73,770.0	73,770.0
2.	Lineal feet of crack around windows (one-half of total)	356.0	356.0
3.	Lineal feet of crack around door	21.0	21.0
4.	Total area of windows, square feet	525.0	525.0
5.	Area of windows with storm sash, square feet	....	522.0
6.	Area of windows without storm sash, square feet	525.0	3.0
7.	Area of door, square feet	24.5	24.5
8.	Infiltration coefficient for windows, Btu per lineal foot of crack per degree Fahrenheit per hour	0.74	0.34
9.	Infiltration coefficient for door, Btu per lineal foot of crack per degree Fahrenheit per hour.	2.00	1.00
10.	Coefficient of heat transmission for windows, Btu per square foot per degree Fahrenheit per hour	1.13	0.45
11.	Coefficient of heat transmission for door, Btu per square foot per degree Fahrenheit per hour	0.52	0.52
12.	Calculated heat loss through doors and windows, Btu per hour	63,800.0	27,070.0
13.	Total calculated heat loss from building, Btu per hour	137,570.0	100,840.0
14.	Calculated saving, per cent	....	26.7
15.	Actual saving from tests, per cent	....	21.0

mission losses through the windows and door are given in Table 2, for which the coefficients were obtained from The American Society of Heating and Ventilating Engineers Guide 1935. The infiltration coefficients given in Item 8 were based on a well fitted window having 5/64 in. crack and 1/32 in. clearance. A frame leakage of 10.8 cu ft per hour obtained from The A. S. H. V. E. Guide 1935, Table 2, page 123, was added to the leakage for windows with and without storm sash, read at a wind velocity of 15 mph from the curves on page 125 of The A. S. H. V. E. Guide. These totals were then reduced 20 per cent to allow for building up of pressure within the building and the results were multiplied by 0.075 and 0.24 to obtain the coefficients in terms of Btu per lineal foot of crack per degree Fahrenheit per hour. The infiltration coefficient for the unprotected door was obtained by using the value of the leakage for a poorly fitted window, as recommended. No data were available for the leakage around a storm door, but since the one used closed against felt strips, it was regarded as a weatherstripped door, and the leakage was assumed as one half of that for a door without weatherstripping. The front door was located in a recess which formed a shallow vestibule when the storm door was installed. The heat loss under these conditions was calculated by using the same coefficient of heat transmission for the two cases, but regarding the door exposed to the outdoor temperature in one case and the mean between the indoor and outdoor temperature in the other.

From Table 2 it may be observed that the calculated heat loss was 137,570 Btu per hour for the building not equipped with storm windows and doors, and 100,840 Btu per hour for the building equipped with storm windows and door. This represented a computed saving of 26.7 per cent as compared with the actual saving of 21 per cent shown at an indoor-outdoor temperature difference of 70 F by the test curves in Fig. 3. This may be regarded as very close agreement considering the uncertainties which necessarily accompany the computation of infiltration losses, and several explanations may be offered to account for the fact that the apparent saving was somewhat greater than the actual. The published coefficients are based on laboratory tests under controlled and readily determinable conditions. In applying these coefficients, the question as to how nearly the actual conditions approximate those stated for the laboratory tests is largely a matter of estimation and judgment.

In the case of the storm windows, the storm sash were positively secured against felt strips. This condition can be readily duplicated and it is probable that coefficients determined from laboratory tests applied reasonably well to the actual installation. Furthermore, the leakage is small as compared with the total heat loss from the building. In the case of the unprotected windows the infiltration depends on the width of crack and the clearance around the frames, both of which are difficult to estimate or measure accurately. This leakage is relatively larger than that around the storm sash, and if it were overestimated it would indicate an apparent saving that would be greater than the actual. It is possible, therefore, that the unprotected windows at the Research Residence were tighter than allowed for in the estimate, thus accounting for the larger apparent saving indicated by the computed results.

The calculations for heat losses do not take into consideration the admission of cold air through doors at the time of entrance. If this loss remained constant in the two installations, it would be a relatively greater proportion of the total heat loss when the building was equipped with storm doors and windows than it would be when the building was not so equipped. Hence neglecting this item in the computations would tend to increase the apparent saving as compared with the actual saving.

The calculated heat losses were based on a wind velocity of 15 mph in order to maintain consistency with the values of the heat transmission coefficients selected from The A. S. H. V. E. Guide, whereas the actual average wind velocity in Urbana, Ill. in zero weather is somewhat less than this. The wind has a greater effect on unprotected windows than on those protected by storm sash, and at lower velocities the differences in infiltration would not be as great as they would be at higher velocities. This would also tend to indicate an apparent saving greater than the actual.

Fuel Saving as Affected by Features of Construction. It is obvious that the percentage of reduction in fuel consumption with and without the use of storm doors and windows is dependent on the nature of the wall construction and the ratio of exposed window surfaces to the net wall surface. For a given room or house, storm windows and doors will effect a larger percentage saving when the wall is well heat-insulated than when it is not. Also, for two rooms of the same size having the same wall construction, but different ratios of window surface to net wall surface, the percentage of fuel saving will be greater when storm windows are applied to the room which has the larger ratio of exposed window surface to net wall surface, than it will be when the storm windows are applied to the room having the smaller ratio.

In this connection, tests of storm windows and doors made under laboratory conditions are of some interest. These tests were made in the room heating testing plant in the Mechanical Engineering Laboratory at the University of Illinois. This plant[3] consisted of two test rooms, each having two wall exposures of frame con-

[3]University of Illinois, Engrg. Experiment Station, *Bulletin No. 223*, Chapter II, pp. 11-17 and Chapter IX, pp. 62-66.

struction, erected inside of a large insulated enclosure. The test rooms were heated with steam radiators, and, by means of refrigerating coils in the large enclosure, the two walls of the test rooms could be exposed to any desired air temperature. For these tests the temperature on the outside of the exposed walls was maintained at 0 F, and the heat loss from the test room was measured by the steam condensation from the radiator. The test room was 9 ft by 11 ft with a 9-ft ceiling, and had two double-hung windows each 2 ft 6 in. by 4 ft 6 in., and an exposed door 3 ft by 7 ft. The ratio of the window area to net wall area was 16.5 per cent and the ratio of the sum of the areas of the windows and door to the net

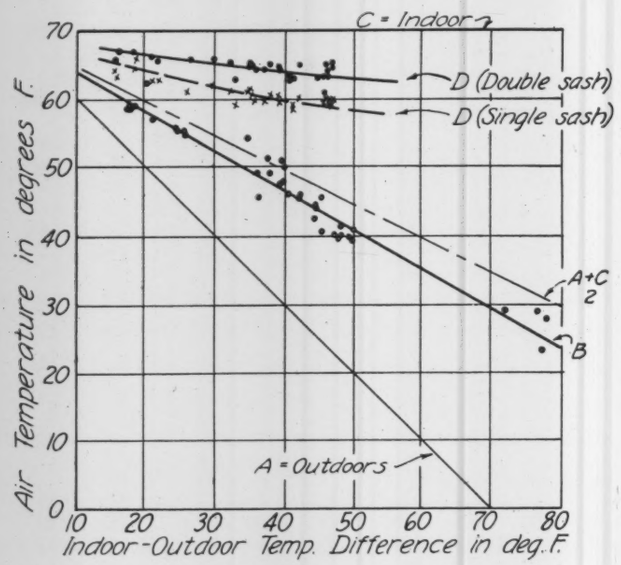


Fig. 4—Air temperatures in connection with storm sash (Thermometer locations indicated by *A*, *B*, *C*, and *D*. See Fig. 2)

wall area was 31.9 per cent. In these tests the steam condensation required to heat the room to 70 F at the 5-ft level was reduced 11.0 per cent when storm windows alone were used, and 31.0 per cent when both storm windows and storm door were installed. The results obtained in the Research Residence, in which the wall construction was similar to that of the laboratory test room, were consistent with those obtained in the laboratory tests. The actual fuel saving was 21.0 per cent, which was intermediate between the reductions in steam condensation of 11.0 per cent and 31.0 per cent shown in the laboratory tests with storm windows alone and with the storm windows and door respectively; while the ratio of the area of openings to that of the net wall was 22.4 per cent in the Research Residence, which was intermediate between the corresponding ratios of 16.5 per cent and 31.9 per cent for the windows alone and for the windows and door in the laboratory test room. The fact that the per cent saving was approximately the same as the ratio of the area of openings to the net wall area in each case is probably only a coincidence, but it is evident that the potential saving increases as the ratio of openings to net wall becomes greater.

Incidental Data. In addition to fuel saving, other advantages incident to the operation with storm sash became evident. The tightly fitting storm sash practically eliminated the entrance of soot, which in the case of the unprotected windows sifted in and collected in sufficient quantity on the white window stools as to make daily cleaning necessary.

The use of storm windows enabled the maintenance of higher indoor relative humidities without condensation on the windows. Observations[4] made at the Research Residence, simultaneously on windows not equipped with storm sash and on two windows provided with storm sash, during a period when the relative humidity indoors was being rapidly increased with a constant outdoor temperature of 26 F, proved that condensation started to appear on the unprotected windows when the relative humidity reached a value of 32 per cent. No condensation appeared on the two windows equipped with storm sash. This agrees very closely with computed curves indicating that, with 40 per cent indoor relative humidity, condensation appears on unprotected windows when the outdoor temperature drops to 35 F while with storm sash the outdoor temperature must drop to 0 F before condensation appears. Operation during a whole season with all of the windows protected with storm sash, however, indicated that if there is any appreciable leakage around the inner sash, some condensation will deposit on the glass in the storm windows in extremely cold weather when high relative humidities are maintained indoors.

In addition to reducing the heat loss from the building, storm windows were also effective in reducing the downward draft of cold air usually present with unprotected windows.[5] This is shown in Fig. 4 from which it may be observed that the temperature of the current of air coming down over the windows, as measured at *D* (see also Fig. 2) was approximately 3 F greater for the windows equipped with storm sash than it was for those not so equipped.

The immediate effect of this reduction in draft was an increase in the air temperature in the living zone of the room, particularly near the floor. The observed room temperature gradients in the dining room are shown in the left hand portion of Fig. 5 for the case (*B*) in which the windows were not protected and for the case (*C*) in which storm windows were used. It may be noted that the air temperature gradient from the 5-ft level to the ceiling was not affected by the installation of storm windows.

With a fixed setting of the controlling thermostat, there was a marked reduction in the total time of fan operation in the forced-air system, accompanying the reduction in fuel saving when the storm windows were installed. For an average outdoor temperature of 25 F, as illustrated in the right half of Fig. 5, the ratio of the time of fan operation to the total time was approximately 40 per cent without storm windows and 30 per cent with storm windows. Since the percentage of time of fan operation compared to total time varies with different plants and with different settings of the controlling thermostats, the numerical values of these percentages can not be regarded as applying to any plant except the one under consideration. They do, however, serve to illustrate the comparative performance of the plant with and without storm windows. The advantages cited with the use of storm windows emphasize the importance of making adequate

[4]University of Illinois, Engrg. Experiment Station, *Bulletin No.* [illegible], Chapter XI, pp. 115-121.
[5]Loc. cit.

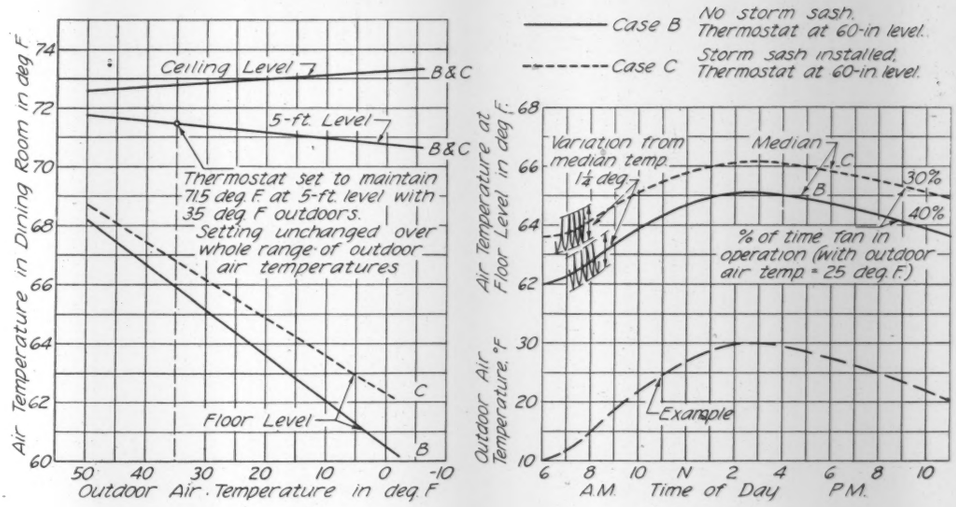

Case B No storm sash. Thermostat at 60-in level.
Case C Storm sash installed. Thermostat at 60-in level.
Ceiling Level
5-ft. Level
B&C
B&C
Thermostat set to maintain 71.5 deg F at 5-ft. level with 35 deg F outdoors.
Setting unchanged over whole range of outdoor air temperatures
Floor Level
C
B
Air Temperature in Dining Room in deg F
Outdoor Air Temperature in deg F
Variation from median temp. 1½ deg
Median
C
B
30%
40%
% of time fan in operation (with outdoor air temp = 25 deg F)
Example
Air Temperature at Floor Level in deg F
Outdoor Air Temperature, °F
A.M. Time of Day P.M.

Fig. 5—Room temperature gradients obtained with and without use of storm sash windows. Room thermostat located 60 in. above floor

provision to reduce the heat losses at what may be regarded as the most vulnerable part of the structure from the standpoint of the heating installation, namely the doors and windows. The problem of heating a room becomes greatly simplified when the ordinary unprotected windows are replaced by adequately protected windows, either in the form of weatherstripping, double-glass, or tightly fitted storm sash, although weatherstripping or double-glass alone are probably not as effective as tightly fitting storm windows.

Conclusions

The following conclusions may be drawn from the results of these tests:

(1) A seasonal fuel saving of approximately 20 per cent may be obtained by equipping a frame building similar to the Research Residence with storm windows and storm doors.

(2) A reasonable agreement can be obtained between the fuel saving effected by storm windows and doors as computed from the calculated heat losses and the actual saving as determined by tests. The computed probable saving tends to be higher than that actually demonstrated by tests.

(3) For a given type of wall construction, the fuel saving effected by storm windows and doors is dependent on the ratio of the area of the windows and doors to the net area of the walls. The potential saving increases as this ratio becomes greater.

(4) Tightly fitting storm sash practically eliminate the entrance of objectionable amounts of soot.

(5) Storm windows make possible the maintenance of higher indoor relative humidities without condensation appearing on the glass.

(6) The use of storm windows reduces the draft of cold air down the windows and increases the temperature of the air near the floor of the room.

Acknowledgments

The results presented in this paper were obtained in connection with an investigation of warm-air furnaces and heating systems which is being conducted by the Engineering Experiment Station of the University of Illinois in cooperation with the *National Warm Air Heating and Air Conditioning Association*. The basic data were obtained at the Research Residence[6] (Fig. 1) and the results will ultimately comprise part of a bulletin of the Engineering Experiment Station of which Dean M. L. Enger is the Director.

[6]The Research Residence in Urbana, Ill., was built, furnished and completely equipped especially for research work in warm-air heating by the *National Warm Air Heating and Air Conditioning Association* in December, 1924.

To Check Misuse of Term—Air Conditioning

The National Better Business Bureau, Inc., has issued a statement defining air conditioning, classifying the minimum requirements of air conditioners and recommending that its definitions be applied by publishers, advertising agencies and advertisers to the censorship and preparation of advertising copy. The bureau stated that it had made a careful inquiry into the subject "with a view toward defining air conditioning for the guidance of all who are interested in maintaining public confidence in advertising."

"We find agreement among the manufacturing industry, architects and heating and ventilating engineers that air conditioning, generally speaking, is the scientific preparation and simultaneous control of the atmosphere within a structure," the bureau said. "The three factors which probably affect human comfort to the greatest degree are temperature, humidity and motion of the air. It is the simultaneous control of these three factors which scientific authorities agree constitutes the minimum requirements of air conditioning.

"Because the functions performed for air conditioning in the sumer differ from those required in the winter and because units are offered to the public which produce air conditioning in the summer, but not in the winter, and vice-versa, the following classifications and minimum requirements of air conditioners have been adopted by the trade, scientific authorities and the bureau:

Summer air conditioning should perform, as a minimum, the following functions: (1) cool the air; (2) dehumidify the air; (3) circulate the air.

Winter air conditioning should perform, as a minimum, the following functions: (1) heat the air; (2) humidify the air; (3) circulate the air.

Year-round air conditioning should perform, as a minimum, the following functions: (1) cool and dehumidify the air in summer; (2) heat and humidify the air in winter; (3) circulate the air.

"It is understood that the functions required by the season of the year are performed automatically and simultaneously to meet the specific minimum requirements of the user.

"The bureau requests the co-operation of all interested in fair advertising in eliminating the use of the term 'air conditioning' or 'air conditioner' or 'air conditioned' to describe such articles as fans, humidifiers, odor absorbers, underwear, hats, etc. Loose terminology of this nature may not necessarily deceive the public, but it paves the way for a manufacturer who may wish to 'cut corners' to offer to the public air conditioning equipment which does not perform the minimum functions of air conditioning as generally understood by the trade, justifying his deception by claiming that the term 'air conditioning' has no exact scientific meaning."

Chicago from Lake Michigan

Chicago Ready for the Meeting and Exposition

THERE are many good reasons why members of the Society will want to attend the 42nd Annual Meeting to be held in Chicago during the week of January 27. Briefly, the matters of interest are: Three Technical Sessions for the discussion of reports and papers; a Get-Together Luncheon for members and guests; the 42nd Annual Banquet and presentation of the F. Paul Anderson Medal and the Past President's Medal; one Joint Session with the *National Warm Air Heating and Air Conditioning Association* and the 4th International Heating, Ventilating and Air Conditioning Exposition at the International Amphitheatre.

Added incentives for the members are: the opportunities to renew old friendships and make new acquaintances and to contribute to the development and advancement of the heating, ventilating and air conditioning field by participation in the discussions and other activities sponsored by the Society.

Members are assured of low rates at the headquarters hotel, the Palmer House, and round trip fares at a rate of *fare and one-third* by rail from all points in the United States and Canada, under the Identification Certificate Plan.

The Committee on Arrangements of the Illinois Chapter headed by J. H. Milliken, General Chairman, has planned a program that will give visiting members and guests several opportunities for get-together functions and a special program of ladies entertainment will be carried out under the direction of Carl F. Hayden.

Registration for the Society's meeting will start on Monday, January 27, at the Palmer House and J. R. Vernon and his Reception Committee will be waiting the arrival of members and guests and will be prepared to furnish full information about the program, points of interest, methods of transportation to the Exposition, etc.

A special assembly place for ladies and a gathering place for members will be maintained throughout the week of the meeting in the Palmer House and it is the local committee's desire that members make full use of these rooms during their stay in Chicago.

On Tuesday, January 28, it is planned to have a Get-Together Luncheon for members and guests and a nationally known speaker will address the gathering. This will be followed by a conference of local chapter representatives of the Society who will discuss problems of local organization administration.

On Wednesday, January 29, the morning session will be devoted to research papers from the Society's Laboratory and several cooperating institutions and in the afternoon members are invited to attend the session in the Stevens Hotel, to be conducted jointly by the *National Warm Air Heating and Air Conditioning Association* and the Society. Wednesday evening brings the social event of importance, the Annual Banquet and Dance which will be held in the Red Lacquer Room of the Palmer House. Oliver J. Prentice of Chicago will be toastmaster and the F. Paul Anderson Medal will be presented to a distinguished member of the Society and the past presidents' medal will be awarded in accordance with the usual custom.

The Committee on Arrangements in charge of the various functions is as follows:

Reception, J. R. Vernon; *Banquet,* J. P. Fleming; *Ladies,* Carl F. Hayden; *Entertainment,* Tom Brown; *Publicity,* Charles E. Price; *Finance,* Elmer W. Rietz.

Some of the papers which have been offered for discussion and which include an interesting variety in subject matter are:

Pyrheliometers and the Measurement of Total Solar Radiation by L. A. Harding.

Corrosion Studies in Steam Heating Systems by R. R. Seeber, F. A. Rohrman and G. E. Smedberg.

Study of The Conductivity of Concrete by Prof. F. B. Rowley.

Comparative Studies of Combustion Results with Various Thermostats by B. E. Shaw.

Saving Effected by Storm Sash by A. P. Kratz and S. Konzo.

Application Factors for Proper Selection of Freon Refrigerating Equipment for Air Conditioning by J. R. Hertzler.

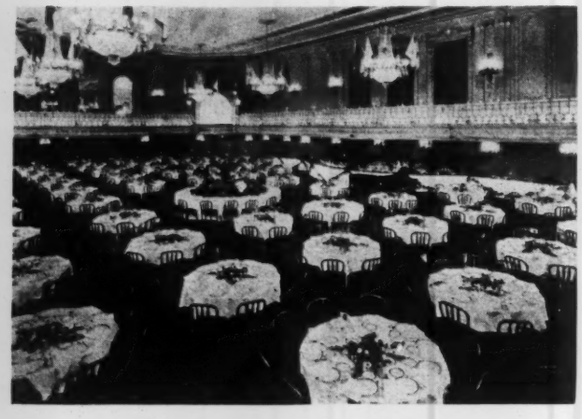
Subjective Reactions of Human Beings to Certain Outdoor Atmospheric Conditions by C.-E. A. Winslow and L. P. Herrington.

Minimum Ventilation Requirements from the Standpoint of Body Odor by C. P. Yaglou.

Comfort Standards for Summer Air Conditioning by F. C. Houghten and Carl Gutberlet.

Room Surface Temperature of Glass Windows by J. E. Emswiler and W. C. Randall.

Heat Transfer through Finned Tubing by Prof. G. L. Tuve.



Palmer House Ballroom ready for the Banquet

Schedule of Events, 42nd Annual Meeting

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
Palmer House, Chicago, Ill.

January 27 (*Monday*)

10:00 a. m.—Registration and Business Session.
2:00 p. m.—Opening of International Heating, Ventilating and Air Conditioning Exposition.
3:00 p. m.—Council and Committee Meetings.

January 28 (*Tuesday*)

9:30 a. m. to
12:30 p m.—Technical Session—Reports and Papers.
12:45 p. m.—Get Acquainted—Luncheon.
2:30 p. m.—Meeting of Chapter Officers.
6:30 p. m.—Past-Presidents' Dinner.

January 29 (*Wednesday*)

9:30 a. m.—Technical Session—Reports and Papers.
12:30 p. m.—Luncheon and Meeting of Nominating Committee.
2:00 p. m.—Warm Air Heating & Cooling Session with *National Warm Air Heating and Air Conditioning Association* at Hotel Stevens.
7:30 p. m.—Annual Banquet, Entertainment and Dance.

January 30 (*Thursday*)

9:30 a. m.—Technical Session—Reports and Papers.
12:30 p. m.—Luncheon and Meeting of the Council.
2:30 p. m.—Meeting of Guide Publication Committee.

The Exposition

The headquarters of the Society will be established at the Exposition in Booth No. 8 near the main entrance and information will be available on membership and various Society activities; THE A.S.H.V.E. GUIDE 1936 will be introduced to the public at this time and representatives of the Illinois Chapter will be present to furnish information and tickets to the various social functions of the Society's meeting. A comprehensive exhibit of the research activities has been planned by the Committee on Research and will be found in Booth No. 10. Extensive arrangements have been made for special low rate transportation by bus, taxi, street car and elevated from the Loop to the International Amphitheatre where the Exposition will be held.

A large parking area capable of accommodating 6000 automobiles will be available to visitors without charge. The 4th International Heating, Ventilating and Air Conditioning Exposition will open on Monday afternoon, January 27, at 2:00 p. m., and will continue each day from noon until 10:30 p. m., until Friday, January 31.

At this time 201 industrial firms have contracted for space indicating that this Exposition will be even larger than any of its predecessors. The scope of the Exposition will cover heating and ventilating, air conditioning, refrigeration, piping and all specialties and there is every indication that thousands will be attracted to this Show, which will offer much of educational value to increase public appreciation for the comfort that can be supplied by the heating, ventilating and air conditioning industries.

The proper conditioning of the air in winter as well as summer will be set forth in its true importance in terms of hundreds of dynamic displays showing the proper heating and humidifying of the air of houses, factories, and office buildings. Design trends toward modern, clear streamline contours will feature the housings of a wide range of devices from large industrial weather makers to the smallest instruments of precision. In the related fields of boilers and furnaces, hot water heaters, unit heaters, ventilating fans and blowers and thermal insulation the trends will be toward advanced operating economy and the simplification of functions both in terms of operating sequences and design of product.

Air conditioning probably began as a science in the need for regulation of temperature and humidity in the factory rather than in the home. Textiles, papers, photographic supplies and many chemicals achieve better production when the weather factors are subject to control. The domestic installations profit of course by this industrial pioneering. Proper air conditioning for any building, be it home or office, requires a careful study of numerous factors. In other words, since few homes or commercial buildings are standard in the sense of being duplicates, their scientific air conditioning offers a distinct engineering problem. Mindful of this one exhibitor at the Fourth International Heating & Ventilating Exposition will show a complete miniature air conditioning installation under automatic control so arranged as to demonstrate effectively the function of each control. The exhibit will be manned by a staff of factory representatives trained to provide complete information of specific interest to architects and engineers as well as to manufacturers and dealers.

Instruments of precision always constitute a very interesting section of the Exposition. On display this year will be humidistats, thermostats, effective temperature controllers, recording instruments for humidity and temperature, sling and aspirating psychrometers, indicators for humidity and temperature, anemometers and air meters. There will also be a complete range of automatic controlling, indicating, and recording instruments for air conditioning in every field. Weather instruments will also be shown. In instrument design there will be new trends toward beauty and durability. Some wall mounted instruments are now given a special finish, making them proof against the corrosive attacks of brine, alkalis, acids, and alternating temperature. One new device, known as a "windowstat" is claimed to end winter air conditioning's greatest problem, the prevention of condensation on the window.

Among the variety of special products which the Exposition will present will be refractory products, stove and furnace linings, new jointless firebrick, acoustic duct linings, automobile and airplane acoustical materials, multi-speed motors especially suited for fan room installations as a means of varying the quantity of air to meet changing weather conditions. Other items will include conduits of all kinds, unit steam mains, and thermal insulation of all kinds including cork and waterproof asbestos. Some conduits will be offered to provide unusual supporting strength for lines under highways and railroad tracks. For district heating projects there will be unit steam mains for quick installation and maximum saving on both initial cost and labor.

The display of unit heaters will include propeller types and floor types with special controls. A new blast heating surface in light weight copper is designed to provide means for the even distribution of steam over the entire face of the surface when steam supply is under graduated control. Of particular interest to school authorities and to all parents for that matter, will be a school-room heating and ventilating unit which in-

Museum of Science and Industry

corporates features to assure ultimate economy in operation and elimination of drafts.

Heat transfer surfaces will be a feature with several exhibitors who will demonstrate them in relation to problems of heating, cooling, and air conditioning. There will be convection heaters, commercial heat transfer units, blast units, unit coolers, and evaporators.

Closely related to the problems of domestic and industrial heating is that of hot water supply. Under this heading the Exposition will provide a most complete review of current practice. There will be circulating pumps, indirect heaters, control valves, one-pipe hot water heating systems and specialties. There will be combination systems including pump, indirect heater and control valves. This is said to make possible the conversion of existing hot water heating plants so as to speed up poor circulation and to provide domestic water winter and summer from the same boiler.

The conduct of the Exposition and all details of exhibit arrangement are in charge of Charles F. Roth of the International Exposition Co.

Partial List of Exhibitors, Fourth International Heating and Ventilating Exposition

Aerofin Corp.
Aerologist, The
Air Controls, Inc., Division of Cleveland Heater Co.
Airtherm Mfg. Co.
Alco Valve Co., Inc.
Allis-Chalmers Mfg. Co.
American Artisan
American Blower Corp.
American Brass Co., The
American Gas Products Corp.
American Radiator Company
American Rolling Mill Co., The
American Society of Heating & Ventilating Engineers
American Sheet and Tin Plate Co.
American Steel & Wire Company
Anderson Manufacturing Co.
Armstrong Bros. Tool Co.
Armstrong Cork Products Company
Armstrong Machine Works
Automatic Burner Corp.
Automatic Heat and Air Conditioning
Automatic Products Co.
Automatic Reclosing Circuit Breaker Co.
Autovent Fan & Blower Co.
Baker Ice Machine Co.
Baldor Electric Co.
Barber-Colman Company
Barnes & Jones, Inc.
Beaver Pipe Tools, Inc.
Bell & Gossett Company
Bethlehem Steel Corporation
Breuer Electric Mfg. Co.
Brown Instrument Co.
Bryant Heater Co., The
Buckeye Blower Co.
Buffalo Forge Company
Burdett Mfg. Co.
Burge Ice Machine Co.
Burgess Battery Co., Acoustic Div.
Burke Stoker & Mfg. Co.
Burnham Boiler Corporation
Carbondale Machine Corp.
Carnegie-Illinois Corporation
Carrier Corporation
Carter Coal Co.
Century Electric Co.
Century Engineering Corp.
Chace Valve Co., W. M.
Chapman Clay Company
Chase Brass & Copper Co.
Chicago Board of Health
Chicago Pump Company
Columbia Steel Company
Cook Electric Co.
Crane Company
Cyclone Fence Company
Dail Steel Products Co.
Dayton Rubber Mfg. Co., The
Delco Appliance Corporation
Department of Smoke Inspection and Abatement
Detroit Lubricator Company
Dole Valve Company
Domestic Engineering
Domestic Engineering Co.
Dunham Company, C. A.
Eagle Picher Sales Co.
Economy Pumping Machinery Co.
Electric Air Heater Company, Div. of American Foundry Equipment Co.
Electrimatic Corporation
Electrol, Incorporated
Ellison Draft Gage Co.
Emerson Electric Mfg. Co., The
Evans Corporation, The George
Excelso Products Corp.
Fairbanks Morse & Co.
Fedders Mfg. Co., Inc.
Fee & Stemwedel, Inc.
Fitzgibbons Boiler Co., Inc.
Fox Furnace Company
Friez & Sons, Inc., Julien P.
Frigidaire Corporation
Fuel Oil Journal
Furblo Company
Garden City Fan Co.
Garwood Industries, Inc.
General Electric Company
Gilbert & Barker Manufacturing Co.
Grinnell Company, Inc.
Hart & Cooley Mfg. Company
Heating Journals, Inc.
Heating, Piping & Air Conditioning
Heating & Ventilating
Hexcel Radiator Co.
Himelblau, Byfield & Co.
Hoffman Specialty Co., Inc.
Holtzer-Cabot Electric Co., The
Hotstream Heater Co., The
Howe Ice Machine Co.
Heil Co., The
Ilg Electric Ventilating Co.
Illinois Engineering Co.
Illinois Testing Laboratories, Inc.
Imperial Brass Mfg. Co., The
Independent Register & Mfg. Co.
Industrial Press, The
Ingersoll-Rand Company
Iron Fireman Mfg. Co.
Jenkins Bros.
Johanson Water Heater Co.
Johns-Manville
Johnson Company, S. T.
Johnson Service Co.
Jones & Laughlin Steel Corp.
Kainer & Company
Keasbey & Mattison Co.
Keeney Publishing Co.
Kelly, Inc., John G.
Kelvinator Corp.
Kewanee Boiler Corp.
Kleen-Heet, Inc.
Korfund Company, The
Lamneck Products, Inc.
Lau Heating Service, Inc.
Lennox Furnace Co., The
McCord Radiator & Mfg. Co.
McDonnell & Miller
Maid-O-Mist, Inc.
Marsh Corp., Jas. P.
May Oil Burner Corp.
Mercoid Corporation, The
Meyer Furnace Co., The
Midwest Piping & Supply Co.
Milwaukee Valve Co.
Minneapolis-Honeywell Regulator Co.
Modine Mfg. Co.
Motor Wheel Corporation
Mueller Brass Co.
Mueller Furnace Co., L. J.
National Regulator Company
National Sheet Metal Contractor
National Tube Company
Nelson Corp., The Herman
Nesbitt, Inc., John J.
Oil Heat
Owens-Illinois Glass Co.
Peerless Electric Company
Penn Electric Switch Co.
Peoples Oil Burner Co.
Perfex Radiator Company
Petrometer Corp.
Plibrico Jointless Firebrick Co.
Plumbing & Heating Trade Journal
Powers Regulator Co.
Practical Instrument Co.
Petroleum Heat & Power Company
Refrigeration & Air Conditioning Institute
Republic Steel Corporation
Richardson & Boynton Co.
Ric-wiL Company, The
Ridge Tool Company, The
Rochester Manufacturing Co., Inc.
Russell Electric Co.
Rega Manufacturing Co.
Sangamo Electric Co.
Sarco Company
Scott-Newcomb, Inc.
Scully Steel Products Company
Silent Glow Oil Burner Corp., The
Steel & Tubes, Inc.
Sterling Engineering Co.
Stevens-Root Co.
Streamline Pipe & Fittings Co.
Sturtevant Co., B. F.
Surface Combustion Corp.
Taco Heaters, Inc.
Tennessee Coal, Iron & R. R. Company
Thrush & Company, H. A.
Timken Silent Automatic Co., The
Trerice Co., H. O.
Turney Corporation
Tuttle & Bailey, Inc.
Uni-Flo Corp.
United States Radiator Corp.
United States Register Co.
United States Steel Corporation Subsidiaries
Viking Pump Company
Waterfilm Boilers, Inc.
Waterloo Register Company, The
Waterman-Waterbury Co., The
Watts Regulator Co.
Wayne Oil Burner Corp.
Webster Electric Company
Webster & Company, Warren
Weil-McLain Co.
Weil Pump Co.
Westinghouse Electric & Mfg. Co.
Westinghouse Electric & Mfg. Co. Air Conditioning Department
Whiting Corp.
Wilson & Co., Inc.
Williams Oil-O-Matic Heating Corp.
Wood Conversion Co.
Worthington Pump Machinery Corp.
York Ice Machinery Corp.
York Oil Burner Co., Inc.
Young Radiator Co.
Youngstown Sheet & Tube Co., The

PRESIDENT'S MESSAGE TO MEMBERS

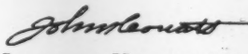
AIR CONDITIONING STANDARDS

Every new, fast moving industry attracts to it many who have a selfish, narrow viewpoint and whose interest is measured only by the size of the immediate profits that may be derived from taking part in it. The air conditioning industry is no exception to the rule. Because of this the structure that is being erected has weaknesses that must be eliminated before sound building can proceed.

The general adoption and acceptance of Standards for Air Conditioning is the first step essential in the establishment of the industry on a proper basis. If the industry would attain its maximum possibilities the confidence of the public must be maintained. Standards that establish design load conditions and minimum performance will insure satisfactory results and contribute to public confidence.

Because of lack of proper engineering and because of lack of minimum Standards no condition of fair competition is found in the industry today. While Standards alone will not provide a complete protection against the unscrupulous chiseler, their adoption would prove an aid in raising the level of new air conditioning work and in placing all bidders on the same basis.

Standards for air conditioning therefore should be developed, promoted and put into effect in every large community; first, for the protection of the customer and the maintenance of public confidence; second, to establish better conditions of fair competition in the industry than exist today; third, to raise the quality level of new air conditioning installations.



President,
American Society of Heating and Ventilating Engineers.

December 1, 1935

Committee to Revise Symbols and Abbreviations

The difficult task of preparing standard letter symbols and abbreviations for scientific and engineering terms is now being undertaken by a committee which is being organized under the procedure of the *American Standards Association*. Standards already approved will be studied by the committee, and many may be revised.

Because of the difficulty involved in writing this universal simplified language for all phases of engineering, the committee is urging those interested to send comments on the standards which have already been approved and suggestions for useful new symbols and abbreviations which are not now included to Dr. J. Franklin Meyer, National Bureau of Standards, Washington, D. C., chairman of the committee.

Twelve standards for letter symbols, abbreviations, and graphical symbols have been developed by the technical committee of the *American Standards Association* which has been at work for many years. Recently, in order to simplify the work of the committee, it was divided into two parts, one covering the letter symbols and abbreviations, and the second covering the graphical symbols.

The committee working on letter symbols and abbreviations, which is now beginning its work, has twelve subcommittees covering the following broad subjects:

Symbols and Signs for Mathematics
Symbols for Physics and Mechanics
Symbols for Structural Analysis
Symbols for Hydraulics
Symbols for Heat and Thermodynamics
Symbols for Photometry and Illumination
Symbols for Aeronautics
Symbols for Electric and Magnetic Quantities
Symbols for Radio
Abbreviations for Scientific and Engineering Terms
Astronomy and Surveying
Geodesy

The committee which will prepare standards on graphical symbols will start work soon and will also request comments and suggestions on its phase of the problem.

The standards already approved by the *American Standards Association* in this field and which are being studied by the committee for possible revision are:

Symbols for Mechanics, Structural Engineering, and Testing Materials (Z10a-1932).
Symbols for Hydraulics (Z10b-1929).
Symbols for Heat and Thermodynamics (Z10c-1931).
Symbols for Photometry and Illumination (Z10d-1930).
Aeronautical Symbols (Z10e-1930).
Mathematical Symbols (Z10f-1928).
Letter Symbols for Electrical Quantities (Z10g1-1929).
Graphical Symbols Used for Electric Power and Wiring (Z10g2-1933).
Graphical Symbols Used in Radio (Z10g3-1933).
Graphical Symbols Used for Electric Traction Including Railway Signalling (Z10g5-1933).
Graphical Symbols for Telephone and Telegraph Use (Z10g6-1929).
Abbreviations for Scientific and Engineering Terms (Z10i-1932).

The annual meeting of the *American Standards Association* will be held in New York, Dec. 11, 1935, according to an announcement just issued by the officers.

Furnace Manufacturers to Meet in January

The mid-winter meeting of the *National Warm Air Heating and Air Conditioning Association* will be held at the Hotel Stevens, Chicago, Ill., January 28 to 30, 1936, according to the announcement of Allen W. Williams, Managing Director.

On the first day the Association's Board of Directors and Standing Committees will hold meetings while the two following days will be devoted to business and technical sessions. An important feature of the meeting will be the Wednesday afternoon session which will be jointly sponsored by the Association and the A.S.H.V.E. A record attendance is anticipated because of the additional attraction of the 4th International Heating, Ventilating and Air Conditioning Exposition which will be held at the International Amphitheatre.

W. H. Carrier Leaves

Mr. and Mrs. W. H. Carrier left New York on the S. S. Washington of the United States Lines for an extended trip that will take them to South Africa, via England, thence to New Zealand, Australia, India and several European countries before returning to the United States. In June Mr. Carrier expects to attend the International Refrigeration Congress in Holland.

NOMINATIONS FOR 1936

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1936, submits the following list of nominees:

For President:

G. L. LARSON, Madison, Wis.

For First Vice-President:

D. S. BOYDEN, Boston, Mass.

For Second Vice-President:

E. H. GURNEY, Toronto, Ont., Can.

For Treasurer:

A. J. OFFNER, New York, N. Y.

For Members of the Council:

Three-Year Term

R. C. BOLSINGER, Norristown, Pa.
S. H. DOWNS, Kalamazoo, Mich.
W. L. FLEISHER, New York, N. Y.
C. M. HUMPHREYS, Pittsburgh, Pa.

Respectfully submitted,

NOMINATING COMMITTEE,
E. A. JONES, *Chairman;*
R. J. TENKONOHY, *Secretary.*

In accordance with the provisions of the Amended Constitution, as given, ballots containing the names of the above candidates will soon be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. B-VIII—Section 10. The Nominating Committee shall consist of one (1) member eligible to vote designated by each Chapter, or his alternate also appointed by the Chapter. The Secretary of each Chapter shall certify to the Secretary of the Society on or before January first the names of the member and alternate selected.

The Committee shall meet at the Annual Meeting of the Society at the call of the Secretary of the Society and shall effect its own organization and elect its own Chairman. At the Semi-Annual Meeting of the Society, if possible, the Nominating Committee shall select the nominees for the ensuing year for the offices of President, First Vice-President, Second Vice-President, Treasurer, and four (4) members of the Council. In any event the names of the nominees shall be certified to the Secretary of the Society before September twentieth, with the written consent of each nominee to fill the office for which he has been selected and their names with the offices to which they have been nominated shall be published in the October issue of the JOURNAL.

Art. B-IX—Section 2. The Secretary shall prepare ballots with the names of all candidates and forward them to the members, eligible to vote, at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election*. The election is governed by the By-Laws for the election of officers, with the single exception that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, adopted at the January, 1919, Meeting, and amended January, 1933, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1936:

Three-Year Term

W. A. DANIELSON, Washington, D. C.
C. E. LEWIS, Dayton, Ohio.
D. W. NELSON, Madison, Wis.
CYRIL TASKER, Toronto, Ont., Can.
C.-E. A. WINSLOW, New Haven, Conn.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

ARTICLE II—ORGANIZATION

Section 1. *Committee on Research*—There shall be a standing committee known as the Committee on Research, consisting of fifteen (15) members each serving for three (3) years and five (5) retiring each year. The outgoing Chairman if serving in that capacity during the last year of his three (3) year term on the Committee shall without election become an additional member of the Committee on Research for one (1) year.

(*a*) The Council shall nominate previous to July first of each year five (5) members to fill the vacancies of those retiring at the next Annual Meeting.

(*b*) The nominations made by the Council shall be published in the October issue of the Society's JOURNAL.

(*c*) Any ten (10) members of the Society eligible to vote may present to the Secretary over their signatures, the name of one (1) or more additional nominees for the Committee on Research, provided such name or names are presented at least sixty (60) days prior to the next Annual Meeting, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

(*d*) The election shall otherwise conform to the regulations provided for the election of officers of the Society in the Constitution, By-Laws and Rules.

(*e*) Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

George M. Getschow Dies

Announcement of the death at his home, 4542 Beacon St., Chicago, on November 2, of George M. Getschow at the age of 65 will come as a shock to his host of friends in the heating field. Mr. Getschow has for many years been president of the Phillips, Getschow Co., and was very active in association affairs having been president of the *Heating, Piping and Air Conditioning Contractors National Association* for two terms, 1922-1924; a director from 1918 to 1924; and chairman of the Board of Directors from 1919 to 1921. He acted as chairman of the Committee on Boiler Output for six years, from 1924 to 1930, and also rendered valuable service to the Chicago Association.

George M. Getschow

He joined the Society in 1906 and during this period of 30 years took an active part in the work, serving as a member of special committees and also taking an active part in the work of the Illinois Chapter.

In addition to his contracting business, Mr. Getschow was secretary and director of the Sloan Valve Co., Chicago, and director and chairman of the Finance Committee of the Builders and Manufacturers Mutual Casualty Co. He was vice president of the *Building Construction Employers' Association* of Chicago; and former chairman of the Board of the Mayfair State Savings Bank.

He was a member of the *Chicago Athletic Association*, Illinois Athletic Club, Edgewater Golf Club, charter life member of the Medinah Athletic Club, the Medinah Temple, Chicago Commandery No. 19 Knights Templar, Oriental Consistory, Wiley M. Egan Chapter No. 126 Royal Arch Masons and St. Cecelia Lodge No. 865 F. & A. M.

On June 13, 1892, he married Lillian L. Burns of Buffalo, N. Y., who died in 1923. Surviving are a daughter, Lorraine M. (Mrs. M. L. Buckley); a son, Roy M. Getschow; seven grandchildren, George and Shirley Buckley, George, Roy, Robert, Lee and Grace Lorraine Getschow; three sisters, Mary Bowles, Lettie Marston and Mabel Stanton of Appleton, Wis.; and two brothers, Herman C. and Richard W. of the same city.

Services were held on November 5, and interment was in Rosehill Cemetery.

In his death the Society has lost a loyal and respected member and the sincere sympathy of the Officers and Council is extended to the members of his family.

Local Chapter Reports

Southern California

November 12, 1935. At the November meeting of the Southern California Chapter the following Officers and Board of Governors were elected for the 1935-36 season:

President—Leo Hungerford.
Vice-President—A. H. Simonds.
Treasurer—A. B. Cooper.
Secretary—Harold Hendrickson.
Board of Governors: H. Bullock, E. H. Kendall, A. G. O'Rear.

The subject for the meeting was a discussion of the paper on Comfort Standards for Summer Air Conditioning, which was presented with special reference to how such standards would generally affect air conditioning contractors. O. W. Ott then stated that his interpretation was that the new tests were made to verify certain criticisms regarding comfort conditioning.

In the discussion which followed, the general consensus of opinion was that, due to the fact that there is such a variation in temperatures ranging from Phoenix, Arizona, where a differential of 20 to 25 deg might be figured down to 15 deg in Los Angeles, and again, 20 deg in Fresno, Cal., that it would be impossible to set up standards based on eastern conditions which would provide comfort conditions in the Southern California district. Other local conditions such as circulation of air also prevail.

It was decided to continue discussion of this subject at the next meeting of the chapter according to the report of W. E. Barnum.

Cleveland

October 10, 1935. Preceding the meeting at the Engineers Club, a get-together dinner was enjoyed by 31 members and visitors, at which Pres. John Howatt of the A.S.H.V.E., Chicago, Ill., was the honored guest. The meeting was called to order at 8:00 p. m. by Pres. G. L. Tuve with an attendance of 125.

Secy. Philip Cohen read a letter from Elmer Reeb, of the local chapter of the *A.I.A.*, thanking the A.S.H.V.E. members for their invitation to attend the meeting.

President Tuve announced the roster of standing committees and F. R. Dickenson reported for the Program Committee and submitted a tentative schedule of meetings for the remainder of the season.

President Howatt was presented and spoke on the subject of Standards for Air Conditioning. He defined the word *standard* as a device placed in the hands of the buyer so that he can evaluate his purchase. Mr. Howatt then described the problems of air conditioning as coming under two principal headings: one on the theoretical side dealing with the setting up of conditions of proper air environment; and the second, involving the practical side and the means of producing those conditions.

President Howatt elaborated on the reactions of individuals to air environment, pointing out how the proportions of latent and sensible heat given off are affected by room temperature. The speaker emphasized the fact that all geographical locations could not have the same set of standards and, further, that such variables as time of occupancy of an air conditioned space complicated the problem.

It was mentioned that the popularity of air conditioning has brought into the field manufacturers and engineers neither qualified nor experienced enough to handle air conditioning and President Howatt stated that the public must have a measuring stick, and that the local Chapter should assume that responsibility and sponsor a set of standards for the community.

A report of the Committee on Standards of the Cleveland Chapter was presented by L. T. Avery, Chairman, recommending that the design wet-bulb temperature for Cleveland be changed from 73 deg wet-bulb, as given in THE A.S.H.V.E. GUIDE 1935, to 75 deg wet-bulb.

H. E. Wetzell, a member of the committee, commented on the standards of the Electrical League of Cleveland and those of the Chicago committee.

President Howatt then continued his talk, commenting on the report presented and explaining the organization of the Chicago committee.

A motion was made by C. F. Eveleth, seconded by J. A. Schurman, and passed, that the report of the committee be accepted and that their recommendation to the Guide Publication Committee be endorsed by the Chapter.

It was also voted that the committee be continued for the purpose of establishing standards for air conditioning and that the president be authorized to enlarge the committee as deemed advisable.

A discussion followed before adjournment at 10:30 p. m.

Illinois

November 18, 1935. A joint meeting was held with the Wisconsin Chapter in the Pere Marquette Room of the Hotel Schroeder, Milwaukee, Wis.

At 7:45 p. m. Pres. C. H. Randolph of the Wisconsin Chapter welcomed the Illinois Chapter to Milwaukee as their guests. Pres. J. H. Milliken of the Illinois Chapter responded and expressed appreciation of his chapter for the hospitality extended them. He reminded those present at the meeting, of the 42nd Annual Meeting to be held in Chicago, January 27, 1935, and called on J. R. Vernon, Chairman of the Entertainment Committee of the Committee on Arrangements, to extend an official invitation to the Wisconsin Chapter.

President Randolph turned the meeting over to Ernest Szekely who introduced H. W. Ellis as the oldest member in point of membership of the Wisconsin Chapter, he having been a member of the A.S.H.V.E. for 26 years. Mr. Szekely then introduced President John Howatt, who responded by expressing his great appreciation at being present at this joint meeting, indicating as it did the stressing of the human equation. Mr. Howatt then indicated the position of industry in the recovery program of the country.

Mr. Szekely introduced Edward P. Rich, one of the speakers of the evening, who spoke on Heating Design for a Federal Housing Project.

He pointed out that government housing projects generally attempted to achieve two results, slum clearance and low rental housing plan. Of the three housing projects originally contemplated for Chicago, his firm, Neiler, Rich & Co., was commissioned to engineer the west side development; the building site constituted 147 acres, being approximately 2500 feet square. The proposed buildings were: three, four and five room—three and four story apartments; two story flats; and two story strip houses. There were 150 separate buildings, a total of 14,700 rooms and a total building cubage of 32,000,000. This original plan was abandoned and a smaller one worked out on a total of 21½ acres. The general design proposed, however, conformed closely to the methods used on the larger plan.

Three methods of heating were considered: 1. Central Heating Plant; 2. Individual Heating Plants; 3. Stove Heat. The central heating plant total boiler horse power 5500—boilers equipped with mechanical stokers—coal, Southern Illinois Screenings—average boiler efficiency 64 per cent. Individual plants, cast iron boilers, hand fired—coal, Pocahontas. Stove heat—One unit per apartment—4382 units using four tons of coke per year.

The estimated life was taken as follows: Central plant 25 years, individual plants 15 years and stove heat 8 years. Comparable total investments: central plant, $1,892,000, individual plants, $1,371,000, and stoves, $356,000. The cost per month per room was as follows: central plant 1.49, individual plant 1.77, stoves 1.75.

On the Jane Addams Project a central plant will be designed to serve the project. 46,950 sq ft of radiation will be served with a low pressure two pipe vacuum system. The buildings will be zone controlled, the radiation will be wall hung. The radiation was sized on an 80 F temperature difference. With 100 per cent occupancy, 1000 people will be housed. There will be 304 apartments, totaling 1206 rooms. This does not include bathrooms, utility rooms or basement rooms. The total building cubage was 1,981,900, direct radiation 42,950 sq ft. One square foot of radiation serves 46.3 cu ft and the average square foot of radiation per room was 35.7. The estimated steam consumption is 450 lb per square foot of radiation per heating season. The total steam per year, including hot water and 5 per cent transmission loss, is calculated at 33,368,643. Yearly steam per capita is 33,368 lb per year. Yearly steam per year per room is 27,668 lb.

In conclusion, Mr. Rich requested comment from the floor. J. H. Volk of Milwaukee spoke of several Milwaukee housing projects on which he was working.

At 9:00 p. m. Mr. Szekely introduced Prof. G. L. Larson, 1st Vice Pres. of the Society, who opened his presentation of Housing Research by reading a rather humorous letter from a house owner in Minneapolis who wished to know what could be done to reduce the high humidity in his home. The point of the letter being the lack of information by the average home owner regarding his heating problems.

Professor Larson presented comparable figures based on plans of identical six room houses but with eight different combinations of construction, whereby the variations were in the kind of walls, windows, etc. These figures were based on the last A.S.H.V.E. GUIDE figures. Under the worst conditions it took 645 sq ft of radiation and 18½ tons of coal to heat the building. Under the best conditions it took 696 sq ft of radiation and 8½ tons of coal. The statistics on the building were 1982 sq ft of wall area, 332 sq ft of glass, 783 sq ft of ceiling and a total cubage of the building of 13,010.

The meeting was closed with a few remarks by John S. Jung, who was Chairman of the Meeting. There were 78 present: Illinois Chapter, 50; Wisconsin Chapter, 28.

Aboard the North Shore Electric train for Chicago at 10:30 p. m. President Milliken of Illinois Chapter called the meeting to order for a brief business session and appointed Messrs. Vernon, Heckel and Ries tellers to count the ballots on the Constitution Amendment. The report of the committee was 50 yes and 0 no. The Constitution Amendment changing the Annual Meeting of the Chapter to the May Meeting was declared adopted by the Chapter. The meeting then adjourned.

Massachusetts

October 15, 1935. Massachusetts Chapter opened the 1935-36 season at the Engineer's Club, Boston, with a dinner and meeting, which was distinguished by the presence of W. T. Jones, past president of the A.S.H.V.E., and D. S. Boyden, who is 1936 nominee for first vice-president of the Society.

Pres. W. A. McPherson announced the Officers, Board of Governors, and Committees of the Chapter for the coming year as given in the annual report.

A subject of vital interest was presented by C. P. Yaglou, Harvard School of Public Health, in a discussion of the paper, Comfort Standards for Summer Air Conditioning by F. C. Houghten and Carl Gutberlet, of the A.S.H.V.E. Research Laboratory.

After outlining the suggested standard, Professor Yaglou indicated that the currently accepted Comfort Zones were not necessarily synonymous with Health Zones, and he expressed the hope that the studies might be continued with subjects whose reactions were less normal than the students of college age on whom the study was based. As an illustration of the work to be done in developing health standards, Professor Yaglou spoke of experiments of Dr. C. A. Mills, Cincinnati, O.

A group discussion followed concerning the factors of air motion and humidity, and the probable commercial acceptance of summer conditioning employing these mediums. This led to the conclusion that general acceptance of a standard both comfortable and healthy is retarded by undue emphasis placed by the public on temperature alone. In response to questions, Professor Yaglou stated that in his opinion the amount of fresh air to be introduced for ventilation would vary under different odor conditions.

The meeting was reported by G. B. Gerrish, newly elected secretary.

Michigan

November 11, 1935. Approximately 85 members and guests attended the November meeting of the Michigan Chapter, which was held at the Springwells Pumping Station, Detroit, as a joint meeting with the local chapter of the *American Society of Refrigerating Engineers.*

At the dinner, the chief engineer gave a brief talk on the Pumping Station and Pres. A. C. Wallich introduced several other engineers in charge of various departments.

Following a brief business session, guides took the members and guests present on a tour of the plant.

Minnesota

November 11, 1935. The annual fall party of Minnesota Chapter took place in lieu of the regular monthly technical meeting. The entertainment committee, consisting of F. W. Legler, F. F. Lange, A. J. Huch and M. H. Bjerken, under the able guidance of F. H. Schernbeck, Chairman, were in charge of all arrangements and are to be complimented for their fine work.

The party was held at the St. Anthony Commercial Club. Dinner was served at 8:00 p. m., after which the meeting was turned over to Mr. Huch, who served as Master of Ceremonies. A supporting cast of 25 entertainers contributed to a lively evening, according to the report of R. E. Backstrom, Secretary.

October 14, 1935. This meeting was held at the plant of the Minneapolis Honeywell Regulator Co. Dinner was served in the cafeteria at 6:30 p. m., after which the meeting was called to order by Vice-Pres. N. D. Adams. After minutes of the September meeting had been read and approved, Mr. Adams turned the meeting over to H. F. Dever, who introduced the speakers.

A. C. Grant, discussed some of the problems encountered in the field of temperature control and pointed out the difficulties which occur in uninsulated homes. In the speaker's opinion, the best methods of overcoming the condition known as *cold* 70 are to provide a more constant firing rate and to install insulation, weatherstrips or storm-windows. Factors that influence temperature control are outside temperature, wind velocity, wind direction, solar radiation, surface moisture, firing rate, humidity circulation, thermal capacity, heat loss factors and infiltration.

Mr. Lott was introduced and discussed humidity and its control. He outlined thoroughly the various methods of introducing moisture in buildings and spoke on control mechanisms.

R. L. Goetzenburger, combustion engineer, was presented and plans to give a talk on combustion control at a later date.

Secy. R. E. Backstrom reports that the 76 members and guests present agreed that this meeting was of exceptional interest.

The Membership Committee, under the direction of H. E. Gerrish, Chairman, met previous to the regular session and outlined ways and means of securing a number of new members for Minnesota Chapter.

Ontario

November 4, 1935. The regular meeting of the Ontario Chapter was held at the Royal York Hotel. Dinner was served at 6:30 p. m. and 62 members and guests were present.

E. H. Gurney introduced the principal speaker of the evening, F. C. Houghten, director of the A.S.H.V.E. Research Laboratory, Pittsburgh, Pa., who gave an illustrated talk on Comfort Standards for Summer Air Conditioning.

Following Mr. Houghten's address, the meeting was opened for discussion and Cyril Tasker, J. W. O'Neill, and H. H. Angus read papers which they had prepared on this subject.

A very beneficial discussion took place and among the participants were Messrs. Marriner, Bishop, Gurney, Bamforth, Thomas, Rybka, Oke, Woollard, and Maddux.

The questions raised included the following items: Were the subjects tested at Pittsburgh for air conditioning comfort all from Pittsburgh, or from other geographical locations? What temperature should be maintained in a lunch room in the summer where the period of occupancy per person is only 30 min or less? It was believed that it would be very desirable to get meteorological data in extreme sections of the continent, *e. g.,* Toronto, New Orleans, San Francisco, etc., for comparison and it was thought that the standards of summer cooling would have to be zoned according to the different meteorological data obtained. It was believed that people coming from different countries and living in different districts would require different standards for air conditioning than those set up at Pittsburgh, *e. g.,* that people living in the locality of Quebec would require different standards than those in New Orleans, Vancouver, etc. It was brought out that summer cooling standards are largely dependent upon the clothing of the people occupying the conditioned space.

Following this discussion, O. L. Maddux extended a vote of thanks to Mr. Houghten for his splendid address, and the meeting then adjourned, according to the report of Secy. H. R. Roth.

Pacific Northwest

November 8, 1935. The first fall meeting of the Pacific Northwest Chapter was held in conjunction with the local section of the *American Society of Mechanical Engineers* at the Edmond Meany Hotel. An exceptionally large number attended from Seattle and surrounding cities, totaling 77.

R. E. Flanders, president of the *A. S. M. E.,* was the speaker of the evening. His talk, entitled New Frontiers, was very ably and interestingly presented, giving every one present a more optimistic outlook on the possibilities of increased standards of living.

Secy. D. C. Griffin has reported that the meeting adjourned at 9:15 p. m.

Philadelphia

October 10, 1935. The meeting of Philadelphia Chapter at the Engineers Club was called to order at 8:00 p. m. by Pres. J. H. Hucker. President Hucker welcomed the members, who were present and Mr. Ireland made a plea for the support of the Red Cross in its coming drive.

A moment of silent prayer for the late W. Roy Eichberg was observed and J. D. Cassell read a resolution on the death of Mr. Eichberg, which had been prepared by W. P. Culbert and W. F. Smith. Upon motion duly made and carried, it was voted that a copy be sent to Mrs. Eichberg and that the resolution be spread upon the minutes.

Minutes of the May 9 meeting were read and approved, as well as the treasurer's report given by L. P. Hynes.

A. H. MacDade reported an attendance of 50, 30 of whom enjoyed dinner at the Club.

Speaking on the drive for membership, R. F. Hunger stated that 14 new members of the A.S.H.V.E. and 20 members of the Philadelphia Chapter had been secured. President Hucker urged united effort to increase the membership.

Secy. H. H. Erickson read Pres. John Howatt's October letter to Chapters on the value of Society membership.

M. F. Blankin gave an interesting short talk on the Summer Meeting of the Society held in Toronto last June.

A proposed amendment to the Constitution and By-Laws of the Philadelphia Chapter to change the date of the annual election from the January to the April meeting, thus having the newly elected officers installed at the regular May meeting to meet the uniform plan suggested by the Council of the Society, was presented by L. C. Davidson. This amendment was submitted and signed by F. D. Mensing, Alexander McClintock, Jr., J. D. Cassell, R. C. Bolsinger, M. F. Blankin and L. C. Davidson. It contained the provision that the present officers would serve until the next annual meeting to be held in April, 1936.

Upon motion duly made and carried, the amendment was accepted and the Secretary was instructed to send copies to members in order that it can be voted upon at the next meeting.

President Hucker turned the meeting over to S. E. Plewes,

who outlined plans for the November meeting and then asked R. C. Bolsinger to present the speaker.

C. F. Mowrey, Oswego, N. Y., was introduced and gave a paper on Heating by Reversed Refrigeration Utilizing Gas, and Its Sequel, which proved very interesting and was well received.

Pittsburgh

November 18, 1935. The meeting was called to order at 7:50 p. m. by Pres. L. B. Pittock in the Auditorium of the U. S. Bureau of Mines. The minutes of the October meeting were read and approved, after which the following Committee Reports were presented:

Program: Chairman J. F. Collins, Jr., reported that F. C. Houghten, Director of the Laboratory, would speak briefly on the recent laboratory paper, Summer Cooling Standards, at the December meeting and Messrs. McGonagle and Tower are to discuss it. The meeting is to be held on December 16 at the U. S. Bureau of Mines. The election of officers will be held at this meeting.

Nominating: Chairman F. C. McIntosh reported the following list of candidates for offices for the year 1936: *For President,* R. J. J. Tennant; *for Vice-President,* M. L. Carr; *for Secretary,* T. F. Rockwell; *for Treasurer,* John F. Collins, Jr.; *for Board of Governors,* L. B. Pittock, retiring President; Percy Nicholls, E. S. Tower.

Amendment to By-Laws: Mr. McIntosh reporting for the committee said that their recommendation was that the Chapter defer action until it was learned what action other local chapters were taking.

Weather Data: Chairman F. A. Gunther stated in a progress report that the committee was studying the weather records of several sources in an attempt to decide on a uniform method of determining the degree day.

A. S. Locke of the Engineering Department of De La Vergne Engine Co. spoke on Space Heating by Reversed Refrigeration. In his introduction he pointed out that from one point of view a refrigeration machine was merely a pump which raised the temperature level of heat. In the practical application of this theory the heat which becomes available at a sufficiently high temperature for space heating ranges from one and a half to three times the heat equivalent of the energy input. Mr. Locke also stated that in comparing reversed refrigeration with other forms of heating, the cheapness, convenience and the relation to space cooling would have to be considered.

Competitive conditions at present make it necessary to size the machine for the cooling requirements instead of for the heating load. This condition, he said, limited the application to mild climates where the cooling season was more important than the heating season, to the office space in certain kinds of industrial plants, and to passenger car heating on electrified railways. Mr. Locke concluded his talk by showing a number of slides.

Thirty members and guests were present, says the report of Theodore F. Rockwell, Secretary.

October 14, 1935. Pres. L. B. Pittock called the meeting to order in the auditorium of the U. S. Bureau of Mines with approximately 18 members and guests present, and the minutes of the May meeting were read and approved.

Reports of committees were taken up and J. F. Collins, Jr., Chairman of the Program Committee, announced that at the November 18 meeting the subject of Reversed Cycle Refrigeration would be discussed. In December F. C. Houghten will report on the paper, Comfort Standards for Summer Air Conditioning, which will be presented at the Society's 42nd Annual Meeting in Chicago, January 1936.

Chairman E. C. Smyers of the Membership Committee reported that one new member from the Pittsburgh district had affiliated with the Society during the summer.

The status of work on the Correlation of Weather Data was given by Mr. Houghten, who stated that two meetings of the committee had been held during the summer and that the Weather Bureau had agreed to compute the number of degree days from the daily mean temperature in conformance with the commonly accepted definition of the term, *degree day.*

F. C. McIntosh read a report of the meeting of Chapter officers held during the Society's Semi-Annual Meeting in Toronto in June.

A letter to Chapters from Pres. John Howatt, Chicago, Ill., was read by Mr. Smyers.

New business was in order and a proposed amendment to the By-Laws of the Pittsburgh Chapter, relative to the term of service of Chapter officers, was referred to the Board of Governors for further study and report.

President Howatt of the A.S.H.V.E. was introduced by Chapter President Pittock and spoke on Our Changing World. Mr. Howatt aroused consumer interest by recounting several anecdotes of old Scotland. He then traced the changes that have taken place in construction and allied interests, stressing the advantages which have accrued to those companies which maintained active research and development departments. He also pointed to the present tendency, which shows the major portion of construction financed by private funds to be in the residential field. Mr. Howatt included in his talk a discussion of the potential dangers of rash promises relative to financial gains resulting from the installation of air conditioning systems and equipment.

President Howatt's talk was well received and the meeting adjourned at 10:15 p. m.

St. Louis

November 5, 1935. A joint meeting of the St. Louis Chapter, A.S.H.V.E., and the local chapter of the *A.S.R.E.* was held at Garavelli's with an attendance of 85 members and guests.

After dinner the business meeting of the Chapter was called to order by Pres. J. W. Cooper and the reading of the minutes of the previous meeting was dispensed with.

Paul Sodemann, Chairman, read the report of the Nominating Committee and R. J. Tenkonohy reported for the Committee on Amendments.

After a recess, the group was joined by the air conditioning class of the Ranken School and listened to a very interesting illustrated lecture by Prof. A. P. Kratz, Urbana, Ill., Chairman of the Committee on Research of the A.S.H.V.E. Professor Kratz spoke on Summer Cooling in the Research Residence and received an enthusiastic vote of thanks for his presentation, according to the report of Secy. A. L. Walters.

Western New York

November 18, 1935. The Dinner Meeting of Western New York Chapter was held at the Touraine Hotel, Buffalo, with Pres. W. E. Voisinet presiding.

National President Howatt's monthly letter was read concerning Our Part in the Prevention of Air Pollution. This matter will be handled by the newly appointed Air Conditioning Code Committee.

The chapter president, Mr. Voisinet, was appointed to serve as Representative on the Nominating Committee and Vice-Pres. B. C. Candee was appointed alternate.

The dues and privileges of the various grades of membership in the A.S.H.V.E. were announced, as was the Chapter dues and activities, with the appeal that all those who were present should join the Society if they were not members.

L. A. Harding then presented the paper written at the Society Research Laboratory entitled, Standards for Summer Air Conditioning, with appropriate comment and explanation of the various testing methods and apparatus involved. He then read the proposed Chicago Code for Air Conditioning Standards, commenting on the various phases and ramifications of the same, and

particular parts which when applied to Buffalo should be slightly changed, as evidenced by the fact that Buffalo during the summer of 1935 had for a maximum but two days 87 deg dry bulb—76 deg wet bulb. These latter figures were suggested as the design load outdoor condition for Buffalo. It was stressed that air change and air distribution was of utmost importance and should receive careful consideration in such a code. Reference was made to the effect of awnings on cooling load and the new English made glass ¼ in. thick, which is claimed to stop 76 per cent of sun heat and admit 60 per cent of normal light.

A. A. Criqui commented on his interpretation of that part of the Chicago Code concerning 2 deg variation between the temperature of incoming air stream and the temperature of air in occupied zone. He suggested that height of occupied zone should be mentioned.

Mr. Candee reported that condenser water temperature on a test conducted on the hottest days this summer was 73 deg in Buffalo. L. P. Saunders reported the temperature at Lockport, N. Y., going as high as 85 deg—largely due to reservoir storage.

W. R. Heath commented on a heat balance test method.

After an informal discussion of the subject, which brought out the opinion that an air conditioning code for Buffalo was necessary, it was voted to authorize President Voisinet to appoint a committee to formulate such a code.

The committee as formed includes the following: Messrs. Beman, Criqui, Friedenberger, Hamlin, Harding, Kaiser, Landers, Mahoney, Meyer, Scanlon and Voisinet.

It was voted unanimously to hold the annual Christmas Party as usual in December at the University Club through the courtesy of Past Presidents Mahoney and Farnham.

A rising vote of appreciation was accorded Mr. Harding by the 73 members and guests in attendance.

Annual Reports of Local Chapters

Cleveland

The following officers and committees are in charge of Cleveland Chapter activities:

President—G. L. Tuve.
Vice-President—E. J. Vermere.
Secretary—Philip Cohen.
Treasurer—H. M. Nobis.
Board of Governors—M. F. Rather, F. R. Dickenson, L. T. Avery.
Program Committee—L. T. Avery, *Chairman*, and F. R. Dickenson.
Membership Committee—H. E. Wetzell, *Chairman*, W. D. Graham, G. B. Longcoy and E. B. Cary.
Entertainment Committee—A. L. Vanderhoof, *Chairman*, J. A. Schurman, Jr., Philip Cohen and F. A. Rodgers.
Finance Committee—C. F. Eveleth, *Chairman*, and T. A. Weager.

A resumé of meetings held during the past season is given:

October 25, 1934. C. V. Haynes, president of the A.S.H.V.E., Philadelphia, Pa., gave a general report in regard to the activities of the A.S.H.V.E. W. E. Heavey, engineer for the Great Lakes Division, U. S. A. Engineers Corps, discussed the Maintenance of Water Levels in the Great Lakes Area. Attendance—24.

November 20, 1934. This was the occasion of a joint meeting with the *Heating, Piping and Air Conditioning Contractors Cleveland Association.* An enjoyable entertainment was provided and A. R. Herske, New York, N. Y., gave an address on Prospects for the Heating and Air Conditioning Industry. Attendance—167.

December 14, 1934. The Cleveland Section of the *American Society of Mechanical Engineers* and the local chapter of the A.S.H.V.E. held a joint meeting. C. E. Mayett, mechanical engineer, Federal Housing Administration, Washington, D. C., spoke on Unique Heating Problems Involved in Federal Housing Projects.

January 15, 1935. This meeting was held at Case School of Applied Science and was preceded by an inspection of the Mechanical Engineering Laboratory. Dr. J. J. Nassau, head of the Department of Astronomy, discussed Why Build Large Telescopes? Attendance—35.

February 26, 1935. H. E. Wetzell was the speaker of the evening and spoke on Welding, illustrating his talk with a display of fittings and a series of slides. Attendance—15.

May 27, 1935. This meeting was devoted to the subject of Residential Air Conditioning. Various phases were discussed by several speakers as follows: Summer and Winter Design Conditions—C. F. Eveleth; Summer and Winter Economics of Insulation, Weatherstripping, Awnings and Shades—H. E. Wetzell; Winter Air Conditioning in the Warm Air Heated Residence—F. A. Kitchen; Winter Air Conditioning in the Radiator Heated Home—George Nachman; Summer Air Conditioning for the Warm Air and Radiator Heated Residence—L. T. Avery; and the Need of Automatic Controls—F. A. Rodgers. Attendance—41.

June 18, 1935. The election of officers for the year 1935-36 was announced and reports of the Finance Committee and Membership Committee were given. Following a discussion, a committee was appointed to study discrepancies in air conditioning standards as outlined in THE A.S.H.V.E. GUIDE and as recommended by the Electrical League of Cleveland.

Illinois

Secy. L. S. Ries has prepared the annual report of the Illinois Chapter and 123 members are on the Chapter membership roll.

A resumé of meetings held from October 1934 to May 1935, follows:

October 8, 1934. P. G. Drantzburg, member of the Secret Service Division of the U. S. Treasury Department, spoke on Counterfeiting. Attendance—54 members.

November 12, 1934. Dr. E. V. Hill gave a talk on Air Conditioning. Attendance—106.

December 10, 1934. N. D. Adams, Rochester, Minn., described the construction and operation of the Franklin Heating Station of the Mayo Clinic. Attendance—38.

January 14, 1935. S. Konzo, University of Illinois, spoke on Forced Air Heating and Cooling in the Research Residence, Urbana, Ill. Attendance—80.

February 11, 1935. J. J. Aeberly discussed the Need of a License Law for the Professional Engineer. This meeting was also a homecoming for Pres. John Howatt of the A. S. H. V. E. Attendance—109.

March 11, 1935. Platte Overton talked on Air Conditioning Existing Homes. Attendance—112.

April 8, 1935. S. R. Lewis, consulting engineer, presented a discussion of Standards for Certified Air Conditioning for Comfort. Attendance—276.

May 14, 1935. John Howatt, president of the A. S. H. V. E., was the guest of honor. Attendance—84.

The following officers and committees served the Chapter during 1934-35:

President—R. E. Hattis.
Vice-President—J. H. Milliken.
Secretary—L. S. Ries.
Treasurer—J. J. Hayes.
Board of Governors—G. H. Blanding, J. J. Haines, S. I. Rottmayer, C. W. DeLand.

COMMITTEES

Membership
G. H. Blanding, *Chairman*
C. F. Hayden
E. M. Mittendorff
C. M. Baumgardner
H. G. Kreissl
G. G. Turner

Meetings and Publication
S. I. Rottmayer, *Chairman*
John Howatt
C. W. DeLand
C. E. Price
E. N. McDonnell

Better Relations
J. J. Aeberly, *Chairman*
S. R. Lewis
H. R. Linn

Finance
J. J. Hayes, *Chairman*
J. H. Milliken
Russell Doherty
John Small
J. J. Haines
A. G. Sutcliffe

Publicity
E. N. McDonnell, *Chairman*
C. E. Price
G. G. Turner
C. M. Baumgardner

Legislative
E. P. Heckel, *Chairman*
A. B. Martin
J. H. O'Brien

Kansas City

Secy. G. L. Bliss has prepared the annual report of the Kansas City Chapter, which has 54 members on the rolls.

The following officers and committees are in charge of activities:

President—C. A. Weiss.
Vice-President—L. R. Chase.
Secretary—G. L. Bliss.
Treasurer—C. A. Flarsheim.
Directors—L. A. Stephenson, A. L. Maillard, H. M. Rudio.
Membership Committee—Carl Clegg, *Chairman;* H. M. Rudio, E. K. Campbell, Jr., F. J. Dean, Jr.
Auditing Committee—David Caleb, *Chairman;* W. E. Gillham, L. A. Stephenson.

The annual report contains a synopsis of meetings held during the past season.

September 24, 1934. John Howatt, Chicago, Ill., First Vice-President of the A. S. H. V. E., spoke on Facts and Fancies of Our Industry. Attendance—24 members and 12 visitors.

October 15, 1934. D. D. Zink gave a talk on CCC Camp Work. Attendance—18 members and 2 guests.

November 12, 1934. G. L. Larson, Madison, Wis., Second Vice-President of the A. S. H. V. E., discussed the subject of Results of Research on Various Methods of Heating in Industrial Types of Buildings. Attendance—30 members and 10 guests.

December 10, 1934. H. M. Rudio spoke on the subject of Central Conditioning Systems and C. A. Flarsheim discussed Individual Room Coolers for Air Conditioning. Attendance—34 members and 13 guests.

January 14, 1935. Leon Mart gave an illustrated lecture on Water Cooling Towers or Devices. Attendance—35 members and 9 guests.

February 18, 1935. E. L. Anderson, Detroit, Mich., spoke on Fan Engineering, Air Conditioning and Sound Control. Attendance—23 members and 16 guests.

March 4, 1935. John Howatt, Chicago, Ill., President of the A. S. H. V. E., visited the Chapter and gave an address on Our Position Today. Attendance—47.

April 8, 1935. N. D. Adams, Rochester, Minn., gave an illustrated talk on Air Conditioning for the Treatment of Various Diseases. Attendance—24 members and 10 guests.

May 13, 1935. H. C. Mueller, Chicago, Ill., presented the subject of Temperature Control with Particular Reference to Summer and Winter Air Conditioning. At this meeting, the annual election of officers was held. Attendance—40 members and 6 guests.

Massachusetts

An outline of meetings of the Massachusetts Chapter held during the past season has been presented by W. A. McPherson. There are now 53 members in good standing on the Chapter rolls.

October 8, 1934. The Federal Housing Act was the subject of the meeting held at Durgin Park Restaurant. Attendance—20.

November 19, 1934. A reception to Pres. C. V. Haynes, Philadelphia, Pa., and other officers of the A.S.H.V.E. and a report on research activities of the Society were the features of the meeting at the Engineers Club. Attendance—80.

December 10, 1934. At the Engineers Club, H. C. Baldwin discussed What We May Expect in 1935. Attendance—50.

January 14, 1935. C. W. Colby described the heating installation at Mt. Holyoke College. Attendance—110.

February 11, 1935. The subject of Fundamental Principles of Humidification and Dehumidification was presented by Prof. James Holt in the Lecture Hall at Massachusetts Institute of Technology. Attendance—80.

March 12, 1935. A joint meeting of the local organizations of the A.S.H.V.E., *A.S.E.E., I.E.S.,* and others was held in Filene's auditorium. A. C. Buensod, New York, N. Y., described the recently completed air conditioning installation in the department store. Attendance—400.

April 10, 1935. A reception was given to John Howatt, Chicago, Ill., president of the A.S.H.V.E. during 1935, at the Harvard School of Public Health. C. P. Yaglou spoke on Minimum Requirements for Ventilation. Attendance—75.

May 20, 1935. The subject of Progress in District Steam Heating in Boston was discussed by D. S. Boyden in a meeting at the Engineers Club. Attendance—40.

At the September meeting of the Board of Governors, officers were elected and committees were appointed as follows for the 1935-36 season:

President—W. A. McPherson.
Vice-President—James Holt.
Secretary—G. B. Gerrish.
Treasurer—L. J. McMurrer.
Board of Governors—L. A. Brissette, Philip Drinker, C. T. Flint, Edgar Shaw, R. S. Franklin, *ex-officio,* and the officers.
Papers and Meetings Committee—Philip Drinker, *Chairman.*
Social Committee—C. T. Flint, *Chairman.*
Membership Committee—L. A. Brissette, *Chairman.*

Western Michigan

Secy. J. J. Troske has prepared the annual report of the Western Michigan Chapter, which has 26 members on the rolls.

The following officers and committees are in charge of activities for the 1935-36 season:

President—P. O. Wierenga.
Vice-President—L. J. Miller.
Secretary—J. J. Troske.
Treasurer—H. F. Reid.
Board of Governors—O. D. Marshall, S. H. Downs, D. L. Taze.
Speakers and Educational Committee—L. G. Miller, *Chairman,* W. W. Bradfield and S. H. Downs.
Entertainment and Program Committee—O. D. Marshall, *Chairman,* H. A. Brinker and T. D. Stafford.
Reception Committee—K. L. Ziesse, *Chairman,* C. R. McConnor, W. J. Temple and J. S. Skillman.
Membership Committee—J. H. Van Alsburg, *Chairman,* W. G. Schlichting, H. Christenson, I. Iverson, C. H. Morton and E. J. Adams.
Employment Representative—C. Lammers.
Publicity Committee—D. L. Taze, *Chairman,* O. D. Marshall, R. W. Wilson and H. J. Young.

Monthly meetings were held during the past season and an outline is given:

October 8, 1934. A meeting was held at the Rowe Hotel with H. M. Armstrong as speaker. Miss Frances Florer, attorney of the Detroit office of the Better Housing Division of the Federal Housing Administration, gave a talk on activities of the Division. Attendance—11 members and 16 guests.

November 12, 1934. A meeting was held at Warm Friend Tavern, Holland, Mich. J. H. Van Alsburg gave a talk on Warm Air Registers. Attendance—12 members and 24 guests.

December 3, 1934. A meeting at the Rowe Hotel had C. V. Haynes, Philadelphia, Pa., president of the A. S. H. V. E., as guest of honor. Attendance—10 members and 6 guests.

January 14, 1935. A meeting was held at the Rowe Hotel with N. S. Yost as speaker of the evening. Attendance—9 members and 4 guests.

February 11, 1935. Michigan State College was host to the chapter when L. P. Breckenridge, professor emeritus of mechanical engineering, Yale University, New Haven, Conn., was guest of honor. Professor Breckenridge spoke on The Progress Made in the Science of Heating and Ventilating During the Last Half Century. Dean H. B. Dirks, Michigan State College, discussed Summer Cooling.

March 11, 1935. A meeting was held at the Occidental Hotel, Muskegon, Mich. The guest of the evening was F. M. Young. Attendance—12 members and 39 guests.

April 8, 1935. A meeting was held at the Community House, Parchment, Mich. R. B. Hayward described Heating and Ventilating Problems Encountered in Paper Mills. Attendance—15 members and 34 guests.

May 25, 1935. Fifteen members and 22 guests were present at the annual meeting of the Chapter at Gull Lake Country Club. The officers in charge of activities for the 1935-36 season were elected.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 38 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by December 16, 1935, these candidates will be balloted upon by the council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
ADSHEAD, BERNARD, Technical Director, Nat'l Air Cond. & Humidifying Co., Ltd., Manchester, England.	F. Rhodes (*Non-Member*) W. H. Reid (*Non-Member*)	O. Cromwell (*Non-Member*) A. P. Reed (*Non-Member*)
BAUER, A. E., Engr., U. S. Air Cond. Corp., Minneapolis, Minn.	L. C. Gross L. P. Hanson	J. V. Martenis J. R. Hall
BEACH, W. R., Sales Engr., Cleveland Elec. Illuminating Co., Cleveland, Ohio.	L. T. Avery A. L. Vanderhoof	Philip Cohen M. F. Rather
BEAN, G. S., Mgr. Stoker Div., Northwestern Fuel Co., Minneapolis, Minn.	W. F. Uhl E. F. Jones	R. W. Otto (*Non-Member*) C. E. Gausman
BISHOP, M. W., Sales Engr., American Blower Corp., Chicago, Ill.	J. H. O'Brien J. J. Haines	J. E. McClellan F. C. Warren
CALL, JOSEPH, Air Cond. Engr., J. J. Pocock, Philadelphia, Pa.	L. C. Davidson L. A. Tucker	M. G. Kershaw R. F. Hunger
CASE, R. H., Mfrs. Repr., Seattle, Wash.	S. D. Peterson W. E. Beggs	D. C. Griffin Lincoln Bouillon
DOME, A. G., Engr., Bryant Air Cond. Corp., Philadelphia, Pa.	W. E. Stark L. C. Harvey	Ernest Szekely Otto Fox
EDELMAN, B. P., Sales Dept., U. S. Air Cond. Corp., Minneapolis, Minn.	J. R. Hall H. E. Gerrish	L. P. Hanson L. C. Gross
ESCHENBACH, S. P., Sales Engr., American Blower Corp., Buffalo, N. Y.	V. P. John A. P. Darlington	H. E. Paetz J. W. Brennan
FAUST, F. H., Engr., General Elec. Co., Bloomfield, N. J. (*Advancement*)	D. W. McLenegan P. S. Lyon	E. W. Roessler (*A.S.R.E.*) Elliott Harrington
GRAHAM, J. M., Sales Engr., B. F. Sturtevant Co., Hyde Park, Mass.	R. W. Sigmund A. C. Bartlett	G. B. Houliston J. F. G. Miller
GRAY, E. W., Sales Engr., The Trane Co., Cleveland, Ohio.	L. T. Avery M. F. Rather	A. L. Vanderhoof H. E. Wetzell
GREGG, S. L., Sales Engr., Potomac Elec. Power Co., Washington, D. C.	L. Ourusoff M. D. Kiczales	A. E. Beitzell J. P. Schaefer (*Non-Member*)
GRIMES, F. M., Engr., T. H. Urdahl, Washington, D. C.	T. H. Urdahl M. D. Kiczales	J. G. Vaughan W. A. Danielson
HEWETT, J. B., Engrg. Mgr., Hudson Air Cond. Corp., Washington, D. C.	Elliott Harrington P. S. Lyon	D. W. McLenegan F. H. Faust
HILL, H. H., Field Engr., Frigidaire Corp., Dayton, Ohio.	C. E. Lewis M. J. Stevenson	J. J. La Salvia H. E. Sproull
HOLMES, A. D., Sales Engr., Plumbers Supply Co., Tulsa, Okla.	Edwin Jones F. X. Loeffler	S. L. Rolland Raymond Dolan
HUDEPOHL, L. F., Pres., T. J. Conner, Inc., Cincinnati, Ohio.	H. A. Pillen G. B. Houliston	K. A. Wright R. W. Sigmund
JOPSON, J. M., Engr., W. M. Anderson Co., Philadelphia, Pa.	W. F. Smith W. P. Culbert	J. H. Hucker S. E. Plewes
KRENZ, A. S., Sales Mgr., Krenz & Co., Milwaukee, Wis.	C. H. Randolph Ernest Szekely	G. L. Larson A. M. Wagner
LITTLE, K. B., Repr., The Brownell Co., Cincinnati, Ohio.	F. J. Ward I. B. Helburn	W. R. Stevens H. A. Pillen
LOVING, W. H., Cadet Engr., Washington Gas Light Co., Washington, D. C.	L. Ourusoff E. V. Fineran	W. A. Danielson W. E. Kingswell
LUDERS, R. H., Student, University of Illinois, Urbana, Ill.	W. H. Severns M. K. Fahnestock	P. E. Mohn (*Non-Member*) E. L. Broderick
MINOR, F. K., Dist. Repr., American Air Filter Co., Cleveland, Ohio.	L. T. Avery M. F. Rather	Philip Cohen A. L. Vanderhoof

CANDIDATES

MORSE, R. D., Branch Mgr., American Blower Corp., Seattle, Wash.

MOZLEY, R. G., Student, G. E. Air Cond. Inst., New York, N. Y.

MULLEN, T. J., Jr., Sales Engr., B. F. Sturtevant Co., Washington, D. C.

NYE, L. B., Cadet Engr., Washington Gas Light Co., Washington, D. C.

O'ROURKE, H. D., Jr., Student, Stevens Inst. of Tech., Hoboken, N. J.

PATRICK, H. M., Partner, Chubbuck & Patrick, Ardmore, Pa. (*Reinstatement and Advancement*)

PAYNE, R. E., Draughtsman, E. I. DuPont de Nemours, Wilmington, Dela.

RITT, C. F., Sales Promotion Mgr., Trane Co., Washington, D. C.

SCHERMER, RICHARD, Payroll Statistician, Commonwealth Edison Co., Chicago, Ill.

STEENECK, K. C., Htg. Engr., John G. Kelly Co., New York, N. Y.

THOMPSON, E. F., Draftsman, E. I. DuPont de Nemours Co., Atglen, Pa.

TUXHORN, D. B., Htg. Engr., L. P. Steuart & Bro., Inc., Washington, D. C.

WHITTAKER, W. K., Htg. & Vtg. Maintenance, Irving Trust Co. Bldg., New York, N. Y.

REFERENCES

Proposers	*Seconders*
S. D. Peterson W. E. Beggs	D. C. Griffin Lincoln Bouillon
J. R. Freeman (*Non-Member*) J. B. Bell, Jr. (*Non-Member*)	Herbert Herkimer Harold Herkimer (*Non-Member*)
J. G. Vaughan T. H. Urdahl	W. A. Danielson E. J. Febrey
L. Ourusoff E. V. Fineran	W. E. Kingswell M. D. Kiczales
Eugene Fezandie (*A.S.M.E.*) John Yellott (*Non-Member*)	F. DeR. Furman (*A.S.M.E.*) C. O. Gunther (*Non-Member*)
P. L. Pryibil W. P. Culbert	J. H. Hucker R. F. Hunger
M. G. Kershaw L. C. Davidson	R. F. Hunger F. D. Mensing
T. H. Urdahl W. A. Danielson	E. J. Febrey W. D. Marshall
J. H. Van Alsburg R. L. Leigh (*Non-Member*)	G. S. Goodwin (*Non-Member*) H. J. Knudsen (*Non-Member*)
A. C. Coonradt (*A.S.M.E.*) M. C. Giannini	L. M. Porter (*S.A.E.*) M. J. Valesio (*A.I.E.E.*)
M. G. Kershaw L. C. Davidson	R. F. Hunger F. D. Mensing
A. P. Kratz M. K. Fahnestock	O. A. Leutwiler (*Non-Member*) Guy Steuart (*Non-Member*)
H. O. Carter (*Non-Member*) B. O. Gilchrist (*Non-Member*)	W. F. Chester (*Non-Member*) L. L. May (*Non-Member*)

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

AUGHENBAUGH, H. E., Br. Mgr., York Ice Mach. Corp., Philadelphia, Pa.

BAIRD, S. A., Consulting Engr., Peoria, Ill.

BECKER, W. A., Sales Engr., Grinnell Co., Chicago, Ill.

BERNHARD, GEORGE, Managing Engr., Associated Htg. Co., Brooklyn, N. Y. (*Advancement*)

BRIGHAM, C. M., Gen. Sales Mgr., C. A. Dunham Co., Chicago, Ill.

GINN, T. M., Estimator & Engr., T. M. Ginn Co., Great Falls, Mont.

HOPPE, A. A., Design & Application Engr., Carrier Engrg. Corp., Oklahoma City, Okla.

KARLSTEEN, G. H., Plant Engr., Dunlop Tire & Rubber Corp., Buffalo, N. Y.

KINGSWELL, W. E., Pres., W. E. Kingswell, Inc., Washington, D. C.

LINCOLN, R. L., Research Engr., Hoffman Specialty Co., Waterbury, Conn.

LIVAR, A. P., Mgr. Mech. Equip. Div., Reynolds Corp., New York, N. Y.

LOCKE, R. A., Mgr., Steel Htg. Boiler Inst, Middletown, Pa.

MCCLINTOCK, WILLIAM, Engr., New York, N. Y.

MENDEN, P. J., Sales Engr., Young Radiator Co., Racine, Wis.

PIKE, WALLACE, Engrg. Designer, Ternstedt Mfg. Co., Detroit, Mich.

RICKNER, C. A., Sales Engr., Kelvinator Corp., Detroit, Mich.

RUFF, A. G., Engr., U. S. Playing Card Co., Norwood Ohio.

SMITH, L. E., Asst. Mgr. Tech. Dept., Frigidaire Corp., Dayton, Ohio.

STUART, M. C., Prof. of Experimental Mech. Engrg., Lehigh Univ., Bethlehem, Pa.

WILTBERGER, C. F., Mech. Engr., Stewart A. Jellett Co., Philadelphia, Pa.

ASSOCIATES

AITKEN, JAMES, Superintendent, Anthes Fdry., Ltd., Winnipeg, Man., Can.

ARGUE, E. J., Salesman, Anthes Fdry., Ltd., Winnipeg, Man., Can.

BONTHRON, R. C., Supervisor, Air Cond. Dealers, Philadelphia, Pa.

COCHRAN, C. C., Br. Mgr., Minneapolis-Honeywell Reg. Co., Milwaukee, Wis.

HANCE, W. W., Draftsman, E. I. DuPont de Nemours Co., Wilmington, Dela.

HUGHES, F. S., Jr., Sales Mgr., Hardin Sash & Door Co., Ft. Worth, Texas.

HUGHEY, T. M., Sales Engr., Westerlin & Campbell Co., Milwaukee, Wis.

LEVERANCE, H. J., Salesman, J. M. O'Connor Co., Wichita, Kans.

O'BRIEN, W. N., Secy. & Treas., O'Brien Equipment Co., St. Louis, Mo.

ROBINSON, G. L., Draftsman, E. I. DuPont de Nemours Co., Wilmington, Dela.

SPENCE, R. T., Engrg. Mgr., Pflugradt Co., West Allis, Wis.

STACK, A. E., Lab. Supervisor, Washington Gas Light Co., Washington, D. C.

WALSH, E. R. Jr., Mgr. Retail Sales, Gilbert & Barker Mfg. Co., Springfield, Mass.

JUNIORS

BLAIR, H. A., Service Engr., Westinghouse Elec. & Mfg. Co., Springfield, Mass.

CAMPBELL, R. E., Htg. Engr., Brooklyn Gas Co., Coney Island, N. Y. (*Advancement*)

CLERICUZIO, G. P., Bloomfield, N. J.

CONSTANT, E. S., Design Engr., Okla. Gas & Elec. Co., Oklahoma City, Okla.

DONOHOE, J. B., Engr. & Estimator, B. F. Donohoe Co., Boston, Mass.

FERGESTAD, MARVIN, Sales Engr., The Insulite Co., Minneapolis, Minn.

MEHL, O. H., Engr., Carrier Engrg. Corp., Chicago, Ill.

MILLER, R. E., Sales Engr., American Radiator Co., Detroit, Mich.

REIK, R. C., Engr., L. E. Stevens Co., Cincinnati, Ohio.

SCHECHTER, J. P., Engr., Domestic Air Cond. Co., Detroit, Mich.

Heating • Piping and Air Conditioning

January-December, 1935—Vol. 7, Nos. 1-12

As will be noted, these abstracts are classified under general heads. In looking for information on a specific subject, it will be well to look through the abstracts under the most suitable heading, and also to look through those under the other headings. For example, some of the heating articles also contain information on air conditioning, and vice versa, *as the grouping has been made on the basis of the subject most prominently covered in the article.*

The index to the Journal Section *of the* American Society of Heating and Ventilating Engineers *is separate (see page* 618).

This index does not include Equipment Developments; Book Reviews; Booklets, Reports, and Papers; Recent Trade Literature; and Conventions and Expositions, departments appearing regularly each month. The Editor's Page in each issue includes items of news, comments on current events, etc.

Air Conditioning

Air Conditioning Aids Manufacture of Ale, by A. B. Wason.
Vol. 7. *No.* 4. *April,* 1935. *p.* 193.
Dawes brewery, Montreal, Canada, modernized by central station cooling and air condition system for fermentation room; advantages of controlled temperature and humidity; photos of fermentation room, dehumidifier, and fans.

Air Conditioning for Motor Buses Announced; System Described.
Vol. 7. *No.* 11. *November,* 1935. *p.* 537.
Method of air conditioning buses developed by Ralph F. Peo and E. P. Heckel described; equipment; load for typical bus; diagrammatic sketch of equipment; view of test car.

Air Conditioning Frees Rotogravure Plant from Weather Hazards, by H. E. Jacobsen.
Vol. 7. *No.* 9. *September,* 1935. *p.* 423.
Air conditioning at Alco Gravure, Inc., Chicago, Ill.; temperatures and humidities for various departments; six condensing units for flexibility; air cycle and distribution; pneumatic temperature and humidity control system.

Air Conditioning—from the Building Owner's Viewpoint, by Paul E. Holcombe.
Vol. 7. *No.* 3. *March,* 1935. *p.* 141.
Reasons for confusion regarding air conditioning on part of prospective purchasers; how such confusion may be clarified; defining air conditioning and partial air conditioning.

Air Conditioning Fundamentals—Total Heat-Entropy Charts for Refrigerants, by Louis A. Harding.
Vol. 7. *No.* 9. *September,* 1935. *p.* 429.
Theory of compression refrigeration cycle; general energy equation; definitions of terms; diagram of Rankine cycle; adiabatic expansion or compression; throttling process; refrigerating effect and weight of refrigerant to circulate per minute; compressor power input; compressor displacement; heat removed by condenser and weight of cooling water required; total heat—entropy diagrams for ammonia, carbon dioxide, sulphur dioxide, methyl chloride, and "Freon"; examples of use.

Air Conditioning in Louisville.
Vol. 7. *No.* 4. *April,* 1935. *p.* 180.
Air conditioning installations in Louisville, Ky., hp connected, kw connected, kw-hr per season, kw additional billing demand.

Air Conditioning in St. Louis.
Vol. 7. *No.* 3. *March,* 1935. *p.* 136.
Number of air conditioning installations and kilowatt load they represent prior to 1933, during 1933, and during 1934 for St. Louis, Mo.; types of buildings air conditioned.

Air Conditioning Installations in Two More Cities Reported.
Vol. 7. *No.* 2. *February,* 1935. *p.* 96.
Number of installations, tonnage, and horsepower for air conditioning installations in Newark, N. J., and Dallas, Texas, for 1934 compared with previous years.

Air Conditioning Maintains Quality of Fruits and Vegetables, by Clarence E. Baker.
Vol. 7. *No.* 8. *August,* 1935. *p.* 369.
Cooling fruits and vegetables; cooling apples in packages; research work summarized; advantages of precooling; preheating for cold weather protection; dry ice refrigerator cars; carbon dioxide gas air conditioning; other gases for air conditioning; photos and description of installation at La Verne (Calif.) Lemon Growers' Association.

Air Conditioning Makes a "Strike," by J. M. Chambliss.
Vol. 7. *No.* 10. *October,* 1935. *p.* 468.
Air conditioning system installed in bowling alley; business increases.

Air Conditioning Modernizes Filene's, by Richard Brunel with Francis A. Westbrook.
Vol. 7. *No.* 9. *September,* 1935. *p.* 434.
Air conditioning installation for Wm. Filene's Sons Co., Boston, Mass., five centrifugal compressors have 1200 ton capacity; layout of system; cross-section of building showing air conditioning equipment; photos of equipment.

Air Conditioning Modernizes Library; Promotes Efficiency, Protects Books, by Ford J. Cumming.
Vol. 7, *No.* 12. *December,* 1935. *p.* 565.
Year 'round air conditioning system for James J. Hill Reference Library, St. Paul, Minn.; the building; outdoor air treating unit; recirculating cooling and dehumidifying units; 52 F water from deep well; ducts and grilles; air circulation; temperature and humidity control; cold water circulation; heating and humidifying; photos of equipment.

Air Conditioning Modernizes Office Building, by S. L. Rolland.
Vol. 7. *No.* 11. *November,* 1935. *p.* 524.
System installed in main office building of Oklahoma Gas and Electric Co., Oklahoma City; two 28 ton ammonia compressors; chilled water circulated to units; conditioning main floor; three zones for fifth floor; control balances indoor with outdoor conditions; conditions maintained; design conditions; comparison of theoretical and actual conditions maintained on typical day; comfort chart; photos of equipment and building; advantages of air conditioned offices.

Air Conditioning New KDKA Studios, by H. W. Reding.
Vol. 7. *No.* 4. *April,* 1935. *p.* 196.
Air conditioning new studios for radio station in Grant building, Pittsburgh, Pa.; air cycle; details of design; control; floor plan; photos of equipment.

Air Conditioning Problems Solved by Spray Water-Air Chart, by William Goodman.
Vol. 7. *No.* 5. *May,* 1935. *p.* 233.
Spray water—air chart simplifies solution of problems involving use of spray water type coolers in industrial and comfort air conditioning; use and examples involving single stage washers; correction of theoretical results; total heat of air at various wet bulb temperatures. (See also article published in August, 1935, issue, p. 382.)

Air Conditioning Protects Aeronautical Instruments, by A. J. Rummel.
Vol. 7. *No.* 6. *June,* 1935. *p.* 276.
Description of air conditioning system for aeronautical repair and test room at San Antonio Air Depot, Duncan Field, Texas; reasons for air conditioning; equipment; control; plan and elevation.

Air Conditioning Rescues Industry from the Weather, by Bayard P. Fonda.
Vol. 7. *No.* 1. *January,* 1935. *p.* 12.
Year-around control of humidity in Waverly Press, Baltimore, Md.; need for air conditioning; difficulty caused by variations in thickness of wood blocks on which printing plates are mounted; instrument devised to study effect of varying air temperatures and humidities on the blocks; graph of results of investigation; adsorption type of dehumidifier installed, using silica gel reactivated by gas firing; schematic diagram of system; construction of dehumidifier; photos of dehumidifier; control; gas and electrical power required; results.

Air Conditioning with Ice, by Clifford F. Holske.
Vol. 7. *No.* 8. *August,* 1935. *p.* 387.
Consumption of ice and load factor for several installations; applications of ice in air conditioning work.

Apartment Building Air Conditioning in Argentina, by Rudolf Kuhlmann.
Vol. 7. *No.* 4. *April,* 1935. *p.* 187.
Air Conditioning system for Kavanagh building, Buenos Aires; 33 story apartment building; 400 ton centrifugal compressor; air distribution scheme; other types of systems for apartment buildings; operating costs; advantages.

Chicago Air Conditioning Standards Ready; Results Emphasized.
Vol. 7. *No.* 11. *November,* 1935. *p.* 539.
Standards prepared by committee; emphasize results; how committee was formed; the standards. (See also "Progress in A. C. Standardization," August, 1935, issue, p. 377.)

Chilled Water Pump Installation for Steam Jet Jobs Requires Care, by J. J. Hayes.
Vol. 7. *No.* 1. *January,* 1935. *p.* 11.
Type of pump and method of installation required to avoid trouble; how one job was corrected.

Choosing the Right Air Conditioning System, by A. Warren Canney.
Vol. 7. *No.* 2. *February,* 1935. *p.* 85.
(Part 3—Basic Differences Between Central Station and Unit System); choice of air conditioning method; fundamentals

involved in a choice; the process of air conditioning sketches and explanation of the different types of systems and apparatus.

Choosing the Right Air Conditioning System, by A. Warren Canney.
Vol. 7. No. 4. April, 1935. *p.* 202.
Fundamental considerations; check list for choice of central station or unit system; relation of air conditioning system to heating; extension of summer systems to year 'round systems, with table to aid decision; importance of ducts to air distribution.

Choosing the Right Air Conditioning System, by A. Warren Canney.
Vol. 7. No. 6. June, 1935. *p.* 287.
Fundamental considerations; direct expansion, cold water coils, and sprays; relation between latent and total heat; coordination of control; outdoor air volume; variations of conventional air conditioning methods.

Choosing the Right Air Conditioning System, by A. Warren Canney.
Vol. 7. No. 8. August, 1935. *p.* 375.
Central station system; considerations in choosing a central plant; importance of control; what the purchaser should look for; diagrams of two types of central station plants.

Choosing the Right Air Conditioning System, by A. Warren Canney.
Vol. 7. No. 10. October, 1935. *p.* 469.
(Part 7—Use of Units); when to use units; location of equipment; direct expansion units and control; table of latent to total heat ratios for different types of spaces, and necessary supply temperature of a saturating conditioner; use of table; example of design using direct expansion coils.

Choosing the Right Air Conditioning System, by A. Warren Canney.
Vol. 7, No. 12. December, 1935. *p.* 577.
Conclusion of series; summary of technical factors influencing the design of the right system to meet requirements; temperature and humidity guarantees do not insure complete satisfaction; outdoor air volumes; control; buyer's emphasis is on comfort.

Comfort Zone Is Not Always the Health Zone, by Lloyd Arnold.
Vol. 7, No. 10. October, 1935. *p.* 489.
Skin's function in control of body temperature; harmful effects of sudden temperature changes; medical profession's viewpoint of air conditioning; need of further research.

Commercial Air Conditioning Jobs Predominate, Report Shows.
Vol. 7. No. 11. November, 1935. *p.* 518.
(Review of air conditioning report issued by Electric Bond & Share Co.); types of air conditioning jobs served by operating companies; what utility company air conditioning statistics cover.

Conservation of Water Required for Air Conditioning, by Rudolf Kuhlmann.
Vol. 7. No. 7. July, 1935. *p.* 333.
Air conditioning jobs in Rio de Janeiro and Sao Paulo, briefly described; conserving condensing water; cooling tower; spray pond; deep well, other methods; photos of equipment.

Consulting Engineer Tells How to Improve Theater Air Conditioning, by D. D. Kimball.
Vol. 7. No. 1. January, 1935. *p.* 14.
(Continued from Part 1, published in December, 1934, issue); introduction of conditioned air at ceiling; types of systems in movie theaters; air distribution; ventilation of accessory spaces; cooling installations; dehumidifiers; air filters; air heaters; duct systems; duct insulation; refrigerating machinery; use of well water for economy.

Control of Squirrel Cage Motors for Heating and Air Conditioning Service, by N. D. Buehling.
Vol. 7. No. 10. October, 1935. *p.* 480.
Use of automatic motor control in heating and air conditioning; starting squirrel cage motors; multi-speed motors and control; applications of automatic starting equipment; internal views of various types of starters; connection diagrams.

Crane Operators Cooled.
Vol. 7. No. 10. October, 1935. *p.* 488.
Cooling units installed in cabs of cranes at A. M. Byers plant; cabs insulated.

Diffusion of Conditioned Air, by Samuel R. Lewis.
Vol. 7. No. 3. March, 1935. *p.* 138.
Importance of proper introduction of conditioned air; use of same units for heating and cooling; providing ventilation with unit air conditioning apparatus; introducing conditioned air to a room; sketches of proper and improper arrangement and location of air inlets and outlets, showing air circulation.

Directory of Industrial and Commercial Air Conditioning Equipment Section.
Vol. 7. No. 1. January, 1935. *p.* 57.
Products classified; trade names; manufacturers' addresses.

Duct Design, Selection of Fan and Motor for Fume Exhaust Systems, by B. F. Postman.
Vol. 7, No. 12. December, 1935. *p.* 572.
Design of fume exhaust system described in detail; sizing the ducts; selection of the fan and motor; fan performance curves; checking up on operation.

Enamel Shop Prevents Contamination of Air, Fouling of Ducts, Reclaims Enamel.
Vol. 7. No. 2. February, 1935. *p.* 95.
Installation of water wash spray booths in enamel shop of Edison General Electric Appliance Co., Chicago, Ill.; reasons for installation; preventing contamination of plant air; value of enamel reclaimed; view of exhaust system for dusting tables.

Estimating Approximate Cost and Capacity of Air Conditioning.
Vol. 7. No. 9. September, 1935. *p.* 433.
(Abstract from paper presented by E. B. Murray); estimating tonnage, initial cost and operating cost for air conditioning for various purposes; cu ft per ton for various types of spaces.

Field's "Merchandise Express" Brings Goods, Comfort to Buyers.
Vol. 7. No. 9. September, 1935. *p.* 444.
Brief description of Marshall Field & Co.'s "Merchandise Express"; ten cars air conditioned; photo of power car.

Flow of Air Through a Fan.
Vol. 7. No. 5. May, 1935. *p.* 236.
Application of stroboscope to study of flow of air through a fan; set-up of apparatus; photo of moving fan and vortex of smoke at blade tip.

Get Conditioned Air to the Occupant!, by D. D. Kimball.
Vol. 7. No. 2. February, 1935. *p.* 91.
Air distribution in theaters and auditoriums; importance of getting the air to the occupant without drafts; arrangement of inlets and outlets; spring and fall operation of theater air conditioning plants; accessibility of equipment; amount of cooling required in theaters.

Guests Like Comfort of Cooled Rooms, Detroit Statler Finds.
Vol. 7. No. 1. January, 1935. *p.* 4.
Survey of guest reactions to air conditioning in Hotel Statler, Detroit.

Heat Balance Analysis for Air Conditioning, by Louis A. Harding.
Vol. 7. No. 11. November, 1935. *p.* 531.
Explanation of heat balance method of analysis and its advantages; nomenclature; an example; table of properties of refrigerants; forms for recording comfort cooling computations.

Heating and Air Conditioning the Newest Stream-Liner.
Vol. 7. No. 3. March, 1935. *p.* 131.
Brief description of heating and air conditioning systems for stainless steel, diesel train of the Boston and Maine and Maine Central railroads, the "Flying Yankee"; activity in railway air conditioning.

H. P. & A. C. Inspection Trips (San Francisco's 5,000 Seat Fox Theater).
Vol. 7. No. 3. March, 1935. *p.* 143.
Brief description and illustrations of the air conditioning and heating equipment of this theater; operating problems; box office value of air conditioning.

Metering Air Conditioning Output, by W. H. Junker.
Vol. 7. No. 10. October, 1935. *p.* 478.
Metering air conditioning service for billing tenants; diagram and photo of instruments, showing hook-up used; computing total tonnage and billing.

Modernize Buildings for Health and Comfort as Well as Economy, by John Howatt.
Vol. 7. No. 2. February, 1935. *p.* 100.
Importance of modernizing for comfort of occupants as well as economy in heating; summer comfort should be provided in modern buildings.

Modernize "Main Street."
Vol. 7. No. 5. May, 1935. *p.* 237.
$50,000 amendment to National Housing Act aimed to promote modernization of industrial and business property; modernizing with air conditioning; references to modernization projects; advantages of air conditioning an office building.

Modernizing Buildings for Profit.
Vol. 7. No. 7. July, 1935. *p.* 339.
$50,000 amendment to National Housing Act; examples of modernizing heating and air conditioning systems; advantages of air conditioning restaurants, offices, hotels, etc.; description of air conditioning system for office of Cupples Co., St. Louis, Mo.; photo of office showing ducts.

Modernizing with Air Conditioning, by Terry Mitchell.
Vol. 7, No. 12. December, 1935. *p.* 581.
Direct expansion "Freon" air conditioning system for National Reserve Life Insurance Co. building, Topeka, Kan.; three compressors offer eight capacity groupings; suction and discharge piping; condenser and receiver located under cooling tower on roof, compressors in basement; control is by zones; the duct layout and the conditioning units; photos of building and the compressors.

Noise in Ventilating Systems.
Vol. 7. No. 2. February, 1935. *p.* 79 (*back section*).
(Answer by D. D. Kimball to reader's question); noise caused by air conditioning and ventilating systems in theater installations; methods used to prevent noise; cleaning of ducts.

Operation and Maintenance of Plant Air Conditioning System to Avoid Service Interruption, by W. C. Giles.
Vol. 7. No. 3. March, 1935. *p.* 127.
Importance of maintenance of industrial air conditioning systems; dirt in circulating water; replacing spray heads and headers; corrosion of humidifiers; maintenance of fans, condensers, and other equipment; checking maintained conditions; log sheet for preserving records of conditions maintained.

Plant Engineer Licks Problem of Removing Moisture-Laden Air, by L. Duckman.
Vol. 7. No. 3. March, 1935. *p.* 137.
Arrangement at Oscar Heineman Corp., Chicago, Ill., for removing moisture-laden air and fog from room containing 140 open vats; plan of arrangement; location of exhaust outlets.

Railway Air Conditioning Makes Rapid Strides.
Vol. 7. No. 1. January, 1935. *p.* 26.
New air conditioned coaches of The New Haven Railroad; features; exterior view and close-up of air conditioning equipment.

Selection and Maintenance of Industrial Air Conditioning Systems, by William A. Hanley.
Vol. 7. No. 1. January, 1935. *p.* 22.
Shell, eliminators and fan; washer insulation; piping; pumps; control; maintenance suggestions.

Selection Chart for Cooling Coils, by Louis A. Harding.
Vol. 7. No. 8. August, 1935. *p.* 386.
Chart for selection of direct expansion cooling coils and directions for use. (See also article published in July, 1935, issue, p. 317.)

South African Gold Mines Adopt Air Conditioning.
Vol. 7. No. 9. September, 1935. *p.* 444.
Brief description of air conditioning sytems for South African gold mines; advantages of air conditioning mines.

Sprinkler Heads Smother Range Hood Duct Fires, by H. G. Schaefer.
Vol. 7. No. 4. April, 1935. *p.* 188.
Use of sprinkler heads for putting out kitchen range hood duct fires; valve sealed open. (Also see comment by John G. Eadie, May, 1935, issue, p. 88, back section.)

Temperature and Humidity Requirements for Air Conditioning in Philippines.
Vol. 7. No. 2. February, 1935. *p.* 102.
Requirements for air conditioning in the Philippine Islands; requirements for office buildings.

"Thermohygrics"—a Suggestion, by Edgar S. Miller.
Vol. 7. No. 5. May, 1935. *p.* 235.
"Thermohygric engineer" suggested as better defining heating, ventilating, and air conditioning engineers.

30-Year-Old Museum Modernized, by Arthur C. Babcock.
Vol. 7. No. 6. June, 1935. *p.* 269.
Alteration and reconstruction of Brooklyn Institute of Arts and Sciences, New York; cost; the old heating and ventilating system; design of new system and construction details; design data; ducts, grilles, and diffusers; section through lighting trough showing ducts; plan of alterations; photos of exterior, indirect lighting cove and air baffles, aluminum grills and diffusers.

Total Installed Air Conditioning Tonnage Increases 21% in 1934.
Vol. 7. No. 1. January, 1935. *p.* 1.
Figures for 13 cities show total installed tons of refrigeration for air conditioning increased during 1934 from 65,000 to 78,500 tons; summary of air conditioning installations 1934 and prior to 1934 in Baltimore, Boston, Birmingham, Chicago, Cincinnati, Kansas City, Philadelphia, Pittsburgh, Northern California, Nashville, Cleveland, Atlanta (and suburbs), Omaha, New Orleans, Detroit, Michigan (except Detroit), New York City (Manhattan only), Oklahoma and Arkansas; types of installations and systems, number of jobs, tonnage and hp. (Tables and graph.)

Two Stage Air Washer Problems Solved by Chart, by William Goodman.
Vol. 7. No. 8. August, 1935. *p.* 382.
(See also article published in May, 1935, issue, p. 233); problems involving two stage counterflow coolers; two stage split air washers; effect of varying proportions of water to each stage.

U. S. Equipment Air Conditions Montevideo Banking Building, by Rudolf Kuhlmann.
Vol. 7. No. 11. November, 1935. *p.* 533.
Brief description of air conditioning and heating equipment at Banco de la Republica Oriental del Uruguay; no radiators in building.

Valuable Byproducts from Waste—Piping and Drying Equipment for Reclaiming Whiskey Still Waste, by Warren Viessman.
Vol. 7. No. 7. July, 1935. *p.* 327.
Byproduct utilization in distillation industry; example; pumping slop from vats, and the piping; separation of liquid from grain; drying pressed material; packing dried grain; average results obtained; steam consumption and power requirements; specifications for the equipment; piping liquid slop; nature of dryer steam load; photos of equipment.

Variations in Air Conditioning Bids.
Vol. 7. No. 9. September, 1935. *p.* 443.
(Abstract of paper presented by J. J. Nance); examples; several reasons air conditioning bids vary.

What About Standards for Air Conditioning?
Vol. 7. No. 6. June, 1935. *p.* 290.
Comments of Samuel R. Lewis, Otto W. Armspach, M. G. Harbula, Wm. V. Hoier, and H. M. Hart on standards for "certified" air conditioning for comfort.

What Air Conditioning Did for My Business.
Vol. 7. No. 1. January, 1935. *p.* 23.
D. L. Toffenetti, head of Triangle Restaurants (Chicago) explains importance of air conditioning to restaurants; advantages of air conditioning candy stores and dress shops; illustration of air conditioned restaurant at Chicago World's Fair.

What Air Conditioning Did for My Business.
Vol. 7. No. 7. July, 1935. *p.* 338.
Advantages of air conditioning a book shop in Kansas City, Mo.

What We Think of Air Conditioning—an interview with Holmes Onderdonk.
Vol. 7. No. 10. October. 1935. *p.* 484.
Reasons for air conditioning Tribune Tower, Chicago, Ill.; 624 ton steam jet plant and 400 individual units; refrigeration costs for June, July and August, 1933, 1934 and 1935; advantages; how air conditioning is advertised.

Why Air Conditioning Bids Vary—the Items in Comfort Cooling Design, by Louis A. Harding.
Vol. 7. No. 7. July, 1935. *p.* 317.
Why bids vary; what are the basic data? sensible heat load; entering air temperature; air outlet temperature for heating; weight of moisture to be removed; tons of refrigeration; dehumidifying washer with bypass; selection of evaporator cooling surface; example of selection; psychrometric chart, formulas, and total heat—entropy diagram for "Freon." (See also selection chart for coils, August, 1935, issue, p. 387, and p. 87, back section.)

World's Highest Air Conditioning System, by A. B. Wason.
Vol. 7. No. 6. June, 1935. *p.* 277.
Air conditioning system for American Cyanamid Co. offices, 57th to 61st floors, R. C. A. building, Rockefeller Center, New York City; zoning; reasons for using centrifugal water vapor refrigeration; cooling condensing water; the central station air conditioning plant; booster fan room layout; distribution of air; refrigerating plant; vibrationless base for compressor; temperature and humidity control; operating costs and operating data; advantage of air conditioning an office; diagram of booster fan arrangement; photos of building, refrigeration machine, and ducts.

Heating

Blast Heating System for a Swimming Pool, by C.C. Hermann.
Vol. 7. No. 2. February, 1935. *p.* 102.
Brief description and diagram of blast heating system for a Y. M. C. A. swimming pool room.

Check Plant and Building Heating Now, by T. Napier Adlam.
Vol. 7. No. 4. April, 1935. *p.* 177.
Four fundamental subdivisions which need consideration; waste in boiler plant; fuel; draft; oil burner; air leaks in flues; boiler water; boiler heating surface; the piping; traps; testing thermostatic elements, renewing old traps.

Check Plant and Building Heating, by T. Napier Adlam.
Vol. 7. No. 6. June, 1935. *p.* 285.
Vacuum pump; boiler return traps; domestic hot water savings; blended water; control; method of returning condensate to boiler from water heater coil through alternating receiver; arrangement for supplying hot water at different temperatures for different uses.

Club Cuts Fuel Cost One-Third, by R. J. Purcell.
Vol. 7. No. 10. October. 1935. *p.* 473.
New York club modernizes by installing forced draft equipment for three boilers; savings achieved.

Construct and Equip the Building for Economy in Heating and Air Conditioning, by Samuel R. Lewis.
Vol. 7. No. 2. February, 1935. *p.* 93.
(No. 3 of a series on building construction); effect of the sun on heating and cooling buildings; allowing for heat from sun in control of building heating systems; reducing heat gain of buildings; infiltration a factor dependent upon building construction.

Cost of Heating Cut by Putting the Heat Where It's Needed.
Vol. 7. No. 3. March. 1935. *p.* 145.
Importance of putting heat where it is needed; equipment for so doing; unit heaters installed to warm up printing presses save fuel by reducing time required to heat up the building; amount of fuel saved; photograph of installation; zoning heating system in office building to furnish heat to first three floors only.

Dam Builders Live in Electrically Heated City.
Vol. 7. No. 3. March. 1935. *p.* 140.
Mason City, Wash., houses workers on Grand Coulee dam project; reasons for heating buildings electrically; extent of electric heating system; cooling bunkhouses for workers on Colorado River Aqueduct project.

Diaphragm Valve Is Dropped for Better Heating Control, by H. G. Schaefer.
Vol. 7. No. 5. May. 1935. *p.* 244.
Better regulation of steam pressure accomplished by lowering diaphragm valve to increase static head, compensating for increase by adjusting counter-weight; why greater sensitivity was obtained.

Dividends from the Plant Heating System.
Vol. 7. No. 2. February. 1935. *p.* 101.
Brief summary of possibilities of reducing heating costs in plants and buildings; curve showing consumption of steam for heating a building with and without control.

Equalizing Hot Water Heating System, by Erwin L. Weber.
Vol. 7. No. 5. May. 1935. *p.* 238.
Importance of balancing hot water heating systems; electro-differential-thermometer developed to facilitate balancing; instrument described; equalizing system in a macaroni factory; economic value of equalization; use of same principle in balancing brine systems and locating leaky radiator traps; photo of instrument in use.

Flue Gas Analysis for Hotel Heating Plant.
Vol. 7. No. 9. September. 1935. *p.* 428.
(Answer to reader's question by Samuel R. Lewis); meaning of Orsat flue gas analysis; correcting conditions indicated.

Handling Fuel Oil from Tank Car to Burners, by Kalman Steiner.
Vol. 7. No. 11. November. 1935. *p.* 538.
Types of fuel oil pumps; speed-viscosity table, showing relation between viscosity, pump speed, type, and size; importance of tight suction line.

Handling Fuel Oil, by Kalman Steiner.
Vol. 7. No. 12. December. 1935. *p.* 575.
Stream-line and turbulent flow; determining pressure drop in piping; chart for determining friction factor; chart showing velocity plotted against pipe size; table for conversion of Saybolt seconds to centipoises and API gravity to specific gravity; formulas.

Heating and Ventilation Methods of Early American Builders Show Skill and Ingenuity, by Carleton W. Campbell.
Vol. 7. No. 9. September. 1935. *p.* 436.
Heating and ventilation methods used by aboriginal Americans; ruins at Mesa Verde National Park and Aztec Ruin National Monument investigated; view of Cliff Palace; view and cross-section of *kivas*, or ceremonial rooms, showing heating and ventilation arrangement.

Heating the Hillside Housing Project, by H. G. Schaefer and Lewis Smith.
Vol. 7. No. 12. December, 1935. *p.* 583.
Description of project; low pressure boiler plant for each block; boilers oil-fired; boiler control; header arrangement; zoning considered; method adopted provides for continuous circulation of sub-atmospheric steam; temperature control system; radiation and heat risers.

H. P. & A. C. Inspection Trips—Installing Heating System, by Francis A. Westbrook.
Vol. 7. No. 7. July. 1935. *p.* 330.
Four views of welded piping and radiator connections at Mellon Institute for Industrial Research, Pittsburgh, Pa.

How Improve Heating? by Samuel R. Lewis.
Vol. 7. No. 1. January. 1935. *p.* 17.
(Answer to hotel operating engineer); can heating of hotel be improved by changing from high to low pressure?; what are the savings?; what changes in system are necessary?;

discussion; recommendations; possibilities of saving by installing stokers, temperature control.

How to Reduce Next Winter's Heating Costs, by J. Earl Selter.
Vol. 7. No. 8. August, 1935. *p.* 378.
Principles of heat conservation; day and night temperatures; temperature control; types of control; what can be accomplished; form for keeping record of heating; importance of instruments; general rules for economical heating.

Insulation Blown in Hollow Mullions and Spandrels of New Post Office Building, by D. W. Burnett.
Vol. 7. No. 7. July, 1935. *p.* 325.
Pneumatic installation of rock wool insulation in post office and custom house at St. Paul, Minn.; estimated fuel saving due to insulation; plan and section of spandrel; plan of steel mullion; plan of window; photos of building and insulation blowing equipment.

Kinks.
Vol. 7. No. 3. March, 1935. *p.* 130.
Removing old boiler from basement without cutting building wall; heating lubricant to flow in piping.

Methods of Using Waste Heat from Diesels, by Perry West.
Vol. 7. No. 2. February, 1935. *p.* 97.
Applications of diesel engines; available waste heat; savings effected by utilizing waste heat; waste gas heaters and boilers; formulas for heat transfer; heat balance; curves for hot water requirements and the coincident usable waste heat in jacket water and exhaust gases from diesel engine driven electric generators in an office building, a hotel, and an apartment.

One of 1934's Biggest Jobs—Rebuilding Chicago Stock Yards, by Walter A. Becker.
Vol. 7. No. 4. April, 1935. *p.* 189.
Central steam plant; underground pipe tunnels; heating 7200 seat amphitheater; ventilation; fan rooms; ducts; supply openings; exhaust ventilation provided by propeller fans; unit heaters in exhibition buildings; steam and return mains; expansion; damage to radiation and piping by fire; cooling Exchange building restaurant; unit heaters in industrial type buildings; pipe insulation and underground piping.

Operating Hotel Boiler Plant.
Vol. 7. No. 2. February, 1935. *p.* 79 *(back section)*.
(Answer by Samuel R Lewis to reader's question; stack temperature; when is boiler operated most efficiently, with overload or underload?; control of stoker and forced draft fan.

Operating Time and Trouble Saved (Stoker Installation), by Sabin Crocker.
Vol. 7. No. 7. July, 1935. *p.* 331.
Advantages of stoker firing and attention to coal and ash handling; methods of stoker installation; stoker and boiler base at floor level; stoker in pit, boiler base at floor level; stoker at floor level, boiler base elevated; photos of typical installations.

Persistent Conservation Efforts Cut Steam for Heating in Half, by Lyman R. Flook.
Vol. 7. No. 11. November, 1935. *p.* 513.
Central heating system at University of Chicago; metering the steam; steam conservation program and results accomplished; ten year tabulation of steam consumption; reducing peak steam load; loss in transmission of steam; steam use report forms and bills for steam; curve showing reduction in steam consumption, 1925-1935; load duration curves; photos of several of the buildings served.

Practical Heating, by Harold J. Taylor.
Vol. 7. No. 7. July, 1935. *p.* 338.
Installing radiators below water line of steam boiler; instructions for installing; figuring radiator size; typical jobs.

Practical Heating, by Harold J. Taylor.
Vol. 7. No. 8. August, 1935. *p.* 372.
Enlarging old boilers for added capacity; replacing old boilers; what to check.

Practical Heating, by Harold J. Taylor.
Vol. 7. No. 9. September, 1935. *p.* 440.
Heating service water with cast iron boiler; selection of capacity; boiler ratings.

Practical Heating, by Harold J. Taylor.
Vol. 7. No. 10. October, 1935. *p.* 486.
Installation of check vales on radiators; dimensions for blow-off tanks for high pressure boilers.

Practical Heating, by Harold J. Taylor.
Vol. 7. No. 11. November, 1935. *p.* 535.
Installing indirect hot water heaters; tapping the boiler; control; tank size; use of pump; heater size; vent valve; stoker fired jobs; boiler capacity; hot water systems; diagram of installation.

Revamping a Twenty-Year-Old Heating System, by George T. Condron.
Vol. 7. No. 3. March, 1935. *p.* 129.
Revamping heating system of St. Paul's Episcopal church, Springfield, Ill.; the old system; objectives of the remodeling work; the new system; stoker installed; advantage of control valve; results with new system; plan of buildings heated; diagram of unsatisfactory type of lift fitting.

School Heating Costs, Other Data, Presented in Graphical Form.
Vol. 7. No. 4. April, 1935. *p.* 199.
Review of study of 24 Iowa school buildings by Prof. R. A. Norman; curves for tons of coal per season and sq ft direct radiation, tons of coal per season and combined equivalent and direct radiation, tons of coal per season and enrollment capacity, tons of coal per season and cubic contents of building, time of fireman per month and cubical contents, power consumption and cubical contents, capacity enrollment and actual total enrollment to cubical contents, direct radiation and combined equivalent and direct radiation, combined direct and equivalent direct radiation and ventilating air, and combined direct and equivalent direct radiation and enrollment capacity; results of study and recommendations.

Simple Changes in Heating Systems and Better Operation Reduce Steam Costs, by George H. Tuttle.
Vol. 7, No. 12. December, 1935. *p.* 570.
Examples of improved operation and minor revisions which have achieved lower heating costs; separate steam line for heating restaurant in office building; separate line to supply steam to water storage tank; effect of study of operating conditions and automatic temperature control; weatherstripping and piping changes; loss due to waste of domestic hot water; tables of monthly steam consumption before and after changes, and per cent savings.

Suggestions for Modernizing Plant Heating.
Vol. 7. No. 1. January, 1935. *p.* 24.
(Comments by Homer R. Linn, C. W. Kimball, and A. W. Moulder); need for an engineer's survey; proper design important; adaptability of unit heaters to plants.

To Keep a Temperature at Any Point, Put the Control Where the Temperature's Wanted, by Samuel R. Lewis.
Vol. 7. No. 6. June, 1935. *p.* 289.
(Answer to reader's question); oil fired boiler in apartment building; indirect water heater; in mild weather, circulation from boiler through water heater stops; cause of trouble; proper location of temperature control.

Trouble Shooting, by William Goodman.
Vol. 7. No. 11. November, 1935. *p.* 528.
Steam heating boiler in theater lost water under certain operating conditions; description of system; analysis of cause; test of system; cause of trouble explained.

Types of Unit Heaters for Industrial Use, by Perry West.
Vol. 7. No. 10. October, 1935. *p.* 487.
Four general types of unit heaters briefly described; method of installation and applications of different types.

Unit Heaters for Industrial Use, by Perry West.
Vol. 7. No. 9. September, 1935. *p.* 419.
Estimating heating load, temperature gradient, infiltration, roof losses, fume and smoke removal, inside temperatures; selection and location of heaters; three methods of placing units sketched; temperature control; supply and return connections; good arrangement of return connection; low pressure system with open returns.

Use of Superheated Steam in Radiators, by A. P. Kratz.
Vol. 7. No. 6. June, 1935. *p.* 281.
(Answer to reader's question); effect on steam consumption of using superheated steam in radiators and heat exchangers.

Piping

Alteration of Pumping Equipment.
No. 7. No. 11. November, 1935. *p.* 517.
Alteration of equipment by means of oxy-acetylene welding and cutting.

Cement Piped at Boulder Dam.
Vol. 7. No. 3. March, 1935. *p.* 146.
Welded piping at Boulder dam used for conveying dry cement from blending plant; construction and layout of the piping; flanged joints facilitate removal of obstructions; air inlets and valve control.

Cold Storage Room Piping Fabricated by Bronze Welding, by T. F. Hooker.
No. 7. No. 4. April, 1935. *p.* 198.
Replacing calcium chloride brine coils in cold storage room; galvanized pipe bronze welded; tests made; test specimens; results; method of welding; advantages; view of test specimens and control end of cooling coil.

Compact Piping Layout for Boiler Feed Pumps, by G. W. Hauck.
Vol. 7, No. 12. December, 1935. *p.* 586.
Photograph and detail of compact piping layout for two steam turbine driven boiler feed pumps for three boilers; valves located for efficient operation.

Creep of Materials at High Temperatures.
Vol. 7. No. 7. July, 1935. *p.* 322.
Application of materials at high temperatures and information on creep abstracted from paper by W. P. Manning.

Design and Erection of a Bulk Fuel Oil Storage Plant, by Kalman Steiner.
Vol. 7. No. 5. May, 1935. *p.* 241.
Piping and heating major problems; factors influencing selection of site; determination of storage capacity; tank size and construction; plant layout; tank design; formula for metal thickness; pumps and piping; plan of piping and tanks; detail of tank structure; photos of piping, tanks, valve header, and pumps.

Design and Erection of a Bulk Fuel Oil Storage Plant, by Kalman Steiner.
Vol. 7. No. 6. June, 1935. *p.* 282.
Selection of pumping equipment; determining pipe sizes; formulas; heating storage tanks; computing heat transfer; formula for mean logarithmic temperature difference; construction of heating coils and detail of coils; steam and condensate piping; photo of track siding.

Design and Erection of a Bulk Fuel Oil Storage Plant, by Kalman Steiner.
Vol. 7. No. 7. July, 1935. *p.* 323.
Estimating required boiler capacity for heating oil; sizing steam and return piping; heating plant offices; welding piping; the question of future generation of electric power for pumping.

Design of Modern Industrial Piping Systems—the Flow of Fluids, by F. L. Snyder.
Vol. 7. No. 1. January, 1935. p. 5.
Investigation, checked by laboratory experiments and operating experience, leads to savings in economical design of industrial piping; discussion of flow of fluids in pipe; Fanning formula; Reynolds number; friction factor and condition of pipe; radius of bend; charts for pressure drop in pipes for various Reynolds numbers for liquids and gases; chart for converting bends into equivalent straight pipe; chart for

friction factor in pipe coils; viscosity conversion chart; explanation and examples of use of charts.

Design of Modern Industrial Piping Systems—Flexibility of Piping, by F. L. Snyder.
Vol. 7. No. 4. April, 1935. *p.* 181.
Inherent flexibility of pipe structures; use of welding fittings for expansion bends; deflection tests; deflection formulas; design data and examples of use; nominal diameter, outside diameter, wall thickness; moment of inertia $(1.5\ D)^{1.66}$ (D is nominal diameter), flexibility multiplication factor, and distance from farthest fiber to neutral axis of pipe for standard steel, extra heavy lap-welded and seamless steel, 250 lb. lap-welded 750 F working temperature, 300 lb seamless steel 750 F working temperature, 400 lb std. lap-welded 750 F working temperature, and 400, 600, 900 and 1500 std. seamless steel 750 F working temperature pipe; modulus of elasticity, allowable fiber stress, and thermal expansion of pipes (Also see July, 1935, issue, p. 324.)

Design of Modern Industrial Piping Systems—New Economies Through Modern Piping Construction, by F. L. Snyder.
Vol. 7. No. 8. August, 1935. *p.* 365.
Thin wall piping standard advocated; advantages; pressure piping code requirements for thickness of pipe; percentage of metal removed from pipe wall by threading; present standard and proposed wall thickness; American and German standard wall thicknesses; examples indicate economies through thinner wall thicknesses; photos of steam lines designed with lighter wall thicknesses; use of alloys.

Don't Jump at Conclusions When Looking for Trap Trouble, by T. H. Rea.
Vol. 7. No. 5. May, 1935. *p.* 240.
Example of typical example where trap draining steam heated drying rolls of a dry milk machine was incorrectly blamed for trouble; leak in syphon pipe the real cause.

Draining Steam-Using Equipment, by T. H. Rea.
Vol. 7. No. 10. October, 1935. *p.* 485.
Steam trap installation and maintenance for steam-using equipment; inspecting and overhauling traps; diagrams of methods of installation.

Flow of Water in Piping Studied with Movie Camera; Results Described Here, by Edgar E. Ambrosius and John C. Reed.
Vol. 7, No. 12. December, 1935. *p.* 578.
Method of studying flow of water in piping by means of movie camera; test set-up; results of study; distribution of velocity and velocity fluctuation across pipe diameter; sudden stoppage of flow; scrubbing action of fluid on pipe wall; flow through orifice; photos of stream-line and turbulent flow, and flow through orifice.

For Better Plant Operation—Meter Your Piping Services, by F. W. Rabe and Hugo Reichenbach.
Vol. 7. No. 2. February, 1935. *p.* 89.
Metering ammonia to three departments of Anheuser-Busch brewery; reasons; method; practical points considered in installing meters; diagrammatic steam flow meter board.

High Pressure—High Temperature Steam Piping Welding, by Sabin Crocker.
Vol. 7. No. 3. March, 1935. p. 132.
Piping at the Connors Creek plant of The Detroit Edison Company for 600 lb, 850 F; stress relieving welds; electric induction device for stress relieving described and illustrated; current consumption; control; purpose of stress relieving; design of flow nozzle for welding in line without distortion; details of small joints; welded sleeve coupling; small valves; socket fittings; attachment of small pipes to large pipes or castings by welding; conclusions.

How to Use Reynolds Numbers in Piping Calculations, by Max W. Benjamin.
Vol. 7. No. 11. November, 1935. *p.* 519.
Importance of accurate estimation of friction loss in power and industrial process piping; formula for pressure loss; Reynolds "functions"; Reynolds number dimensionless; converting Reynolds "functions" to Reynolds number, with table of factors; identifying Reynolds "functions," with tables; identifying proper friction loss formula; recent articles on subject compared; using the rational method of calculation; table of friction loss formulas.

Installing Piping in Cramped Quarters, by G. W. Hauck.
Vol. 7. No 4. April. 1935. *p.* 194.
Fabricated piping with flanged and welded joints for exhaust header for new engine described; details of design.

Lead Piping for Process Liquids.
Vol. 7 No. 8. August. 1935. *p* 373.
Chemicals handled by lead piping; temperature limits; "burning" or welding lead; wiped joints; photos of lead acid lines in pulp and paper plant, burned joints, and final wiping of joint.

Metallic Pipe Insulation.
Vol. 7. No. 11. November, 1935. *p.* 527.
Brief description of tests on metallic insulation as pipe covering; heat transfer coefficient.

Method of Steam Jacketing Pipe for Handling Heavy Oil, Tar, by G. W. Hauck.
Vol. 7. No. 11. November, 1935. *p.* 527.
Description of construction of 2½ in. piping for heavy road oil and tar steam-jacketed by means of 4 in. line; detail of end joints; cross-over connections.

New Process Piping Layout Speeds Paint Production Schedule, by S. I. Rottmayer.
Vol. 7 No. 5. May, 1935. *p.* 229.
Expansion of paint and varnish plant's activities called for replanning production program; two systems of storage tanks; the piping; supporting the piping; terminus of 26 piping systems at platform scale; threaded joints; schematic diagram of piping; photos of pumps; piping, and tanks.

New Sewage Treatment Plant Involves Big Piping Job, by A. F. Bowers.
Vol. 7 No. 9. September, 1935. *p.* 438.
New addition to Milwaukee, Wis., sewage treatment plant on Jones Island; the treating process; piping an important part of plant; amount of piping installed; metering the air; four views of the plant and piping.

"On the Job" in Piping Maintenance, by W. H. Wilson.
Vol. 7. No. 9. September, 1935. *p.* 441.
How alert maintenance of industrial piping saves time and trouble; examples; location of steam traps for proper maintenance attention.

Pipe Insulation Pays.
Vol. 7. No. 2. February, 1935. *p.* 90.
Table of heat loss from pipe per sq ft of surface for different temperatures and various insulation thicknesses; amount of fuel insulation saves.

Pipe Welding—Practical Field Testing and Instruction of Welders, by D. O. Ferguson.
Vol. 7. No. 6. June, 1935. *p.* 272.
Preliminary remarks to welders; types of welds made and tested; preparation of test coupons; the tests, nick break, tensile, ductility or free bend, and reverse bend; requirements for satisfactory weld; welding instruction; photos of pipe beveling device, welding by backhand method, coupon cutting machine, and tensile testing machine.

Pipe Welding—Practical Field Testing and Instruction of Welders, by D. O. Ferguson.
Vol. 7. No. 7. July, 1935. *p.* 335.
Classification of welders; follow-up tests; reports to welding supervisors; features and summary of program for testing and training welders.

Piping Pointers, by B. C. Rinehart.
Vol. 7. No. 10. October, 1935. *p.* 479.
Isometric drawings aid in operation and maintenance of piping systems; examples; isometric of piping for locomotive boiler washing system.

Removing Moisture from Compressed Air, by A. W. Loomis.
Vol. 7. No. 9. September, 1935. *p* 442.
Harmful effects of water in compressed air; location of intake; aftercoolers and moisture separators; amount of water to be removed; view of compressor, aftercooler, and receiver.

Resistance of Valves and Fittings to Flow of Fluids.
Vol. 7. No. 11. November, 1935. *p.* 534.
Chart showing resistance of valves and fittings to flow of fluids; example of use; tests upon which chart is based described briefly; pressure drop through globe valves in steam and water lines with pressure below and above disc.

Selecting Traps for Steam Piping, by T. H. Rea.
Vol. 7. No. 1. January, 1935. *p.* 19.
Traps on steam distribution mains must do two things—remove water of condensation without steam loss, and air or other incondensable gases; condensation due to warming up a cold line as well as from radiation loss must be considered; traps must be installed so that the condensation will get to them; steam condensed in warming up piping and by radiation losses; tables; spacing traps, selecting proper size, and getting condensate to the trap; diagram of steam header drainage trap installation.

Simplified Method for Solving Piping Problems, by Siegfried W. Spielvogel and Samuel Kameros.
Vol. 7. No. 9. September, 1935. *p.* 425.
Simplified method for checking an assumed piping layout for intensity of end reactions and determination of bending moments; procedure explained; examples.

Simplified Method for Solving Piping Problems, by Siegfried W. Spielvogel and Samuel Kameros.
Vol. 7. No. 10. October, 1935. *p.* 474.
(Part 2 of article; Part 1 published in September, 1935, issue, p. 425); examples of analysis of pipe bend with sloped branch, combination of straight and curved elements; centroid of circular arc; moments of inertia and products of inertia of 180 deg, 90, and 45 deg arcs.

"Somebody's Connected a Water Line to My Air Line," by John W. Hieronymus.
Vol. 7. No. 3. March, 1935. *p.* 144.
Why water is sometimes discharged with compressed air; amount of water which condenses; how the situation may be corrected; sketch of installation of air separator and air trap.

Specifications for Radiographic Examination of Steel Castings for Piping Service, by Herbert R. Isenburger.
Vol. 7. No. 11. November, 1935. *p.* 530.
Specifications which have proved practical in use.

Telemetering Aids Operation of District Steam Distribution System, by T. E. Purcell.
Vol. 7. No. 10. October. 1935. *p.* 465.
Telemetering system for Allegheny County Steam Heating Co., Pittsburgh, Pa.; theory of method; the system and its operation; operating conditions transmitted; the telemetering equipment; system operators office; map of distribution system showing metering circuits; photo of transmitter and recorder.

Use of Backing Rings in Pipe Welding.
Vol. 7. No. 4. April. 1935. *p.* 197.
Detailed data on backing rings used in the welding of 600 lb 850 F steam piping for Connors Creek plant described in February, 1935, issue by Sabin Crocker; instructions to field force for use of rings.

Vacuum Tube Sounds Warning If Freezing Threatens Piping, by Francis A. Westbrook.
Vol. 7. No. 6. June. 1935. *p.* 286.
Vacuum tube unit blows horn to avoid freezing of sprinkler system piping at Gotham Silk Hosiery Co., Dover, N. J.; photo of unit.

Welding High Pressure—High Temperature Steam Piping, by Sabin Crocker.
Vol. 7. No. 2. February, 1935. *p.* 81.
Rebuilding Connors Creek plant of Detroit Edison Co. for 600 lb. 850 F steam; objectives of welded design; welding methods and quality control; qualifying welders; graphical recording device for showing how consistently the welder lays on a bead; details of the larger piping—bevel, backing rings; laboratory studies on large welded joints. (Also see information on backing rings. April, 1935. issue. p. 197.)

Welding High Pressure Steam Piping at U. S. Industrial Alcohol Co. Plant, by J. A. Freiday.
Vol. 7, No. 12. December, 1935. *p.* 568.
Description of welding by oxy-acetylene process of power and process steam piping for plant reconstruction project; erecting 8,400 ft., 12¾ in. outdoor steam line; qualifying welders; testing the line; insulation; welding power plant piping; testing; number of welds made per day; stress relieving.

Journal Section of American Society of Heating and Ventilating Engineers

January—December, 1935,—Vol. 7, Nos. 1-12

Air Conditioning and Ozone, Mar. ... 151
Air Conditioning Manufacturers' Association Moves to Washington, May ... 258
Air Conditioning Manufacturers' Meeting, July ... 362
Air Diffusion in Ventilation Systems, R. C. Jordan, May ... 253
Air Supply to Classrooms in Relation to Vent Flue Openings, F. C. Houghten, Carl Gutberlet and M. F. Lichtenfels, June ... 300
(Research Laboratory Paper.)
All Electric Heating, Cooling and Air Conditioning System, An, Philip Sporn and D. W. McLenegan, Aug. ... 402
Alt, H. L., Sun Effect and the Design of Solar Heaters, Feb. ... 111
Anderson Medal to Be Awarded, F. Paul, May ... 259
A.S.A. Piping Standards Adopted, Sept. ... 458
A.S.H.V.E. Annual Meeting Program, Jan. ... 49
A.S.H.V.E. Guide 1935, Feb. ... 119
A.S.R.E. Holds Meeting, July ... 362
Bishop Humidifier Co. Organized, Jan. ... 47
Brandt, A. D., Kenneth Morse and W. H. Lehmberg, A Laboratory Study of Minimum Ventilation Requirements: Ventilation Box Experiments, Jan. ... 44
Broderick, E. L., A. P. Kratz, S. Konzo, M. K. Fahnestock and, Study of Summer Cooling in the Research Residence for the Summer of 1934, Jan. ... 29
Building Code Correlating Committee Organized, Oct. ... 506
Bureau of Mines Activities to Be Expanded, June ... 299
Bureau of Standards Sound Tests, Aug. ... 401
Candidates Elected, Jan. ... 56
Feb. ... 126
Mar. ... 176
Apr. ... 228
May ... 268
June ... 316
July ... 364
Aug. ... 418
Sept. ... 464
Oct. ... 512
Nov. ... 564
Dec. ... 612
Candidates for Membership, Jan. ... 55, 56
Feb. ... 124, 125, 126
Mar. ... 175, 176
Apr. ... 226, 227, 228
May ... 267, 268
June ... 315, 316
July ... 363, 364
Aug. ... 418
Sept. ... 463, 464
Oct. ... 511, 512
Nov. ... 563, 564
Dec. ... 611
Carbon Monoxide Alarm and Ventilation Control, A. F. C. Houghten and Linwood Thiessen, Mar. ... 149
Chapter Reports, Jan. ... 52, 53, 54, 55
Feb. ... 122, 123, 124
Mar. ... 172, 173, 174
Apr. ... 223, 224, 225, 226
May ... 263, 264, 265, 266
June ... 312, 313, 314, 315
July ... 361
Aug. ... 416
Sept. ... 460
Oct. ... 507, 508, 509, 510, 511
Nov. ... 560, 561, 562
Dec. ... 605
Characteristics of Registers and Grilles, J. H. Van Alsburg, June ... 304
Check the Calendar—Chicago, January 27-31, Oct. ... 504
Chemical Dehydration of Air, H. J. Kaufman, Oct. ... 493
Chicago for the Meeting and Exposition, Sept. ... 459
Chicago Ready for the Meeting and Exposition, Dec. ... 600
Chicago Standards for Certified Air Conditioning, Samuel R. Lewis, Sept. ... 452
Classroom Drafts in Relation to Entering Air Stream Temperature, F. C. Houghten, H. H. Trimble, Carl Gutberlet and Merle F. Lichtenfels, July ... 356
(Research Laboratory Paper.)
Classroom Odors with Reduced Outside Air Supply, F. C. Houghten, H. H. Trimble, Carl Gutberlet and Merle F. Lichtenfels, May ... 247
(Research Laboratory Paper.)
Colors Identify Danish Pipe Lines, Sept. ... 451
Comfort Standards for Summer Air Conditioning, F. C. Houghten and Carl Gutberlet, Nov. ... 543
(Research Laboratory Paper.)
Committee to Revise Symbols and Abbreviations, Dec. ... 603
Commission of Russian Sanitation, Mar. ... 151
Cooling and Air Conditioning in an Ale Brewery, C. P. Creighton and F. J. Friedman, July ... 352
Cooling Requirements of Single Rooms in a Modern Office Building, F. C. Houghten, Carl Gutberlet and Albert J. Wahl, Apr. ... 207
(Research Laboratory Paper.)
Creighton, C. P. and F. J. Friedman, Cooling and Air Conditioning in an Ale Brewery, June ... 352
Data on U. S. Soil Temperature Correlated, Feb. ... 118
Deaths
Christian, C. W., Mar. ... 174
Donnelly, Mrs. James A., Apr. ... 226
Eichberg, W. R., Aug. ... 417
Getschow, G. M., Dec. ... 605
Jellett, Stewart A., May ... 262
Junkers, Hugo, Apr. ... 226
Macon, W. W., Feb. ... 119
Robb, J. M., July ... 363
Small, John D., Aug. ... 417
Dust Problem in Air Conditioning, The, F. B. Rowley, June ... 293
Electric Hot-Water Supply, Apr. ... 221
Entertainment Events at Buffalo, Mar. ... 170
Fahnestock, M. K., E. L. Broderick, A. P. Kratz and S. Konzo, Study of Summer Cooling in the Research Residence for the Summer of 1934, Jan. ... 29
Faust, F. H., L. Levine, and F. O. Urban, A Rational Heat Gain Method for the Determination of Air Conditioning Cooling Loads, Aug. ... 391
Fourth Heating and Ventilating Exposition Announced, Apr. ... 222
Friedman, F. J., C. P. Creighton and, Cooling and Air Conditioning in an Ale Brewery, July ... 352
Fuel Saving Resulting from the Use of Storm Windows and Doors, A. P. Kratz and S. Konzo, Dec. ... 595
Furnace Manufacturers to Meet in January, Dec. ... 603
Galson, Henry L., Using the Reversed Cycle Refrigerating Principle for a Self-Contained Heating and Cooling Unit, Oct. ... 497
Greenburg, Leonard, C.-E. A. Winslow and, The Thermo-Integrator—A New Instrument for the Observation of Thermal Interchanges, Jan. ... 41
Gutberlet, Carl, and Albert J. Wahl, F. C. Houghten, Cooling Requirements of Single Rooms in a Modern Office Building, Apr. ... 207
Gutberlet, Carl, Merle F. Lichtenfels, F. C. Houghten, and H. H. Trimble, Classroom Drafts in Relation to Entering Air Stream Temperature, July ... 356
Gutberlet, Carl, Merle F. Lichtenfels, F. C. Houghten and H. H. Trimble, Classroom Odors with Reduced Outside Air Supply, May ... 247
Gutberlet, Carl, M. F. Lichtenfels and F. C. Houghten, Air Supply to Classrooms in Relation to Vent Flue Openings, June ... 300
Gutberlet, Carl, F. C. Houghten and, Comfort Standards for Summer Air Conditioning, Nov. ... 543
Heat Absorbing Glass Windows, W. W. Shaver, Sept. ... 447
Heat Conductances of Adobe, Hugh M. Milton, Jr., Sept. ... 457
Heating a Building with Cold Water, Jan. ... 40
Herrington, L. P., C.-E.A. Winslow and, Subjective Reactions of Human Beings to Certain Outdoor Atmospheric Conditions, Nov. ... 551
Houghten, F. C., and Carl Gutberlet, Comfort Standards for Summer Air Conditioning, Nov. ... 543
Houghten, F. C., and Linwood Thiessen, A Carbon Monoxide Alarm and Ventilation Control, Mar. ... 149
Houghten, F. C., Carl Gutberlet and Albert J. Wahl, Cooling Requirements of Single Rooms in a Modern Office Building, Apr. ... 207
Houghten, F. C., Carl Gutberlet and M. F. Lichtenfels, Air Supply to Classrooms in Relation to Vent Flue Openings, June ... 300
Houghten, F. C., John Howatt and, Report of the Committee on Research for 1934, Mar. ... 152
Houghten, F. C., H. H. Trimble, Carl Gutberlet and Merle F. Lichtenfels, Classroom Drafts in Relation to Entering Air Stream Temperature, July ... 356
Houghten, F. C., H. H. Trimble, Carl Gutberlet and Merle F. Lichtenfels, Classroom Odors with Reduced Outside Air Supply, May ... 247
Howatt, John, and F. C. Houghten, Report of the Committee on Research for 1934, Mar. ... 152
H.P. & A.C.C.N.A. Annual Convention, July ... 362
Importance of Climate, Apr. ... 218
Institution of Heating and Ventilating Engineers Meeting, June 24-26, June ... 311
Insulation and Ventilation of Hospital Operating Rooms to Reduce Summer Temperature, R. B. Saxon, Apr. ... 219
James, John W., Joins A.S.H.V.E. Staff, June ... 311
Jordan, R. C., Air Diffusion in Ventilation Systems, May ... 253
Kaufman, H. J., Chemical Dehydration of Air, Oct. ... 493
Konzo, S., M. K. Fahnestock, E. L. Broderick and A. P. Kratz, Study of Summer Cooling in the Research Residence for the Summer of 1934, Jan. ... 29
Konzo, S., A. P. Kratz and, Fuel Saving Resulting from the Use of Storm Windows and Doors, Dec. ... 595
Kratz, A. P., S. Konzo, M. K. Fahnestock and E. L. Broderick, Study of Summer Cooling in the Research Residence for the Summer of 1934, Jan. ... 29
Kratz, A. P., and S. Konzo, Fuel Savings Resulting from the Use of Storm Windows and Doors, Dec. ... 595
Laboratory Study of Minimum Ventilation Requirements: Ventilation Box Experiments, A., W. H. Lehmberg, A. D. Brandt and Kenneth Morse, Jan. ... 44
(Cooperative Research Paper.)
Large-Ion and the Small-Ion Content of Air in Occupied Rooms, G. R. Wait and O. W. Torreson, Feb. ... 105

Lehmberg, W. H., A. D. Brandt and Kenneth Morse, A Laboratory Study of Minimum Ventilation Requirements: Ventilation Box Experiments, Jan..... 44
Levine, L., F. O. Urban and F. H. Faust, A Rational Heat Gain Method for the Determination of Air Conditioning Cooling Loads, Aug..... 391
Lewis, Samuel R., Chicago Standards for Certified Air Conditioning, Sept..... 452
Lichtenfels, Merle F., F. C. Houghten, H. H. Trimble, Carl Gutberlet and, Classroom Drafts in Relation to Entering Air Stream Temperature, July..... 356
Lichtenfels, Merle F., F. C. Houghten, H. H. Trimble, Carl Gutberlet and, Classroom Odors with Reduced Outside Air Supply, May..... 247
Lichtenfels, M. F., F. C. Houghten, Carl Gutberlet and, Air Supply to Classrooms in Relation to Vent Flue Openings, June..... 300
McLenegan, D. W., Philip Sporn and, An All Electric Heating, Cooling and Air Conditioning System, Aug.. 402
Meeting of Joint Committee on Refrigeration, Oct..... 506
Mid-Year Meeting of Furnace Manufacturers, July..... 362
Milton, Hugh M., Jr., Heat Conductances of Adobe, Sept... 457
Morse, Kenneth, W. H. Lehmberg, A. D. Brandt and A Laboratory Study of Minimum Ventilation Requirements: Ventilation Box Experiments, Jan..... 44
Nelson, D. W., Oil Burning in Residences, July..... 343
Nominations for 1935, Jan..... 51
Nominations for 1936, Oct..... 503
Nov. 557
Dec. 604
Of Interest to Members, Sept..... 461
Oil Burning in Residences, D. W. Nelson, July..... 343
Opens Industrial Sales Division, July..... 362
Performance of Fin-Tube Units for Air Heating, Cooling and Dehumidifying, G. L. Tuve, Dec..... 589
Philadelphia Chapter's Tribute to Stewart A. Jellett, June 312
Plans and Aims of Bureau of Mines, Feb..... 110
President's Message:
Mar. 159
Apr. 223
May 261
June 311
July 362
Aug. 416
Sept. 460
Oct. 506
Nov. 559
Dec. 603
Proceedings of the 41st Annual Meeting, Mar..... 160
Proceedings of the Semi-Annual Meeting 1935, Aug..... 411
Program, 41st Annual Meeting, Jan..... 50
Program, Semi-Annual Meeting 1935, June..... 310
Rational Heat Gain Method for the Determination of Air Conditioning Cooling Loads, A, F. H. Faust, L. Levine and F. O. Urban, Aug..... 391
Report of the Committee on Research for 1934, John Howatt and F. C. Houghten, Mar..... 152
Rowley, F. B., The Dust Problem in Air Conditioning, June 293
Saxon, R. B., Insulation and Ventilation of Hospital Operating Rooms to Reduce Summer Temperature, Apr.. 219
Shaver, W. W., Heat Absorbing Glass Windows, Sept.... 447
Society to Hold 42nd Annual Meeting in Chicago, Nov.. 558
Sporn, Philip, and D. W. McLenegan, An All Electric Heating, Cooling and Air Conditioning System, Aug. 402
Standards for Drawings and Drafting Room Practice, July 355
Stoker Manufacturers Elect Officers, Jan..... 47
Study of Summer Cooling in the Research Residence for the Summer of 1934, A. P. Kratz, S. Konzo, M. K. Fahnestock and E. L. Broderick, Jan..... 29
(Cooperative Research Paper.)
Subcommittees of A.S.A. Standards for Drawings, Sept... 460
Subjective Reactions of Human Beings to Certain Outdoor Atmospheric Conditions, C.-E. A. Winslow and L. P. Herrington, Nov..... 551
Sun Effect and the Design of Solar Heaters, H. L. Alt, Feb. 111
Tentative Program, Semi-Annual Meeting, 1935, May..... 261
Thermo-Integrator—a New Instrument for the Observation of Thermal Interchanges, The, C.-E.A. Winslow and Leonard Greenburg, Jan..... 41
Thiessen, Linwood, F. C. Houghten and A Carbon Monoxide Alarm and Ventilation Control, Mar..... 149
To Check Misuse of Term—Air Conditioning, Dec..... 599
Toronto in June, June..... 309
Toronto Is the Meeting Place, May..... 260
Toronto Prepares, Apr..... 222
Torreson, O. W., G. R. Wait and, Large-Ion and the Small-Ion Content of Air in Occupied Rooms, Feb..... 105
Trimble, H. H., Carl Gutberlet, Merle F. Lichtenfels and F. C. Houghten, Classroom Drafts in Relation to Entering Air Stream Temperature, July..... 356
Trimble, H. H., Carl Gutberlet, Merle F. Lichtenfels and F. C. Houghten, Classroom Odors with Reduced Outside Air Supply, May..... 247
Tuve, G. L., Performance of Fin-Tube Units for Air Heating, Cooling and Dehumidifying, Dec..... 589
Unit Air Cooling Equipment Classified by NRA, Jan..... 43
Urban, F. O., F. H. Faust and L. Levine, A Rational Heat Gain Method for the Determination of Air Conditioning, Cooling Loads, Aug..... 391
Using the Reversed Cycle Refrigerating Principle for a Self-Contained Heating and Cooling Unit, Henry L. Galson, Oct. 497
Van Alsburg, J. H., Characteristics of Registers and Grilles, June..... 304
Wahl, Albert J., F. C. Houghten and Carl Gutberlet, Cooling Requirements of Single Rooms in a Modern Office Building, Apr. 207
Wait, G. R., and O. W. Torreson, Large-Ion and the Small-Ion Content of Air in Occupied Rooms, Feb..... 105
Winslow, C.-E.A., and Leonard Greenburg, The Thermo-Integrator—a New Instrument for the Observation of Thermal Interchanges, Jan..... 41
Winslow, C.-E. A. and L. P. Herrington, Subjective Reactions of Human Beings to Certain Outdoor Atmospheric Conditions, Nov..... 551
Work-Relief Bill, May 258

Equipment Developments

For your convenience in obtaining more information about any of this equipment, see coupon on page 103 . . . Add the new products and companies listed here to your Directory Section which you received in your January 1935 HEATING, PIPING AND AIR CONDITIONING and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed.

New Welders Have Many Features

No. 618—New "Flexarc" d-c welder recently announced embodies a number of improvements. Equipped with a single dial preset control with which the welding current can be set to the exact number of amperes, this welder is able to maintain constant arc in spite of speed changes of the driving motor caused by line fluctuations. Open circuit voltage, well below hazardous values, provides safety for the operator yet retains all desirable arc characteristics, states the maker. The moment the arc is struck the set adjusts itself immediately to the required preset value. This welder is a compact unit designed for general welding service or production work with bare, dust coated or heavy coated electrodes.

The set is self-contained from the conduit box to the welding terminals. The outer shell consists of two parts bolted together. A one piece common shaft supported by two sealed ball bearings carries the rotating parts. Meters, exciter, rheostat, reactor, unnecessary pushbuttons, field discharge resistor, starter holding coil, and underframe are eliminated. No load input to the machine over the entire range has been reduced.

The welding generator operates on a new magnetic control principle, utilizing a magnetic shunt in the armature reaction flux path. By this means a generator is obtained which has no shunt field and requires no field rheostat, exciter, or external reactor, and yet which has the proper volt-ampere characteristic. This principle also allows accurate adjustment of welding current over a wide range by means of a purely mechanical control. The output current of the welding generator is adjusted by means of iron damper plates which are operated by single point "adjustomatic" control. These plates serve as a magnetic shunt for the reaction flux of the machine, and their position with respect to the main flux path determines the welding current. Damper coils on the damper plates resist flux variation in the plates and serve to stabilize the machine preventing surge and droop of the welding current. To set up for a given welding current the operator turns the handwheel until the current dial, which is geared to the handwheel shaft, reads the desired value. The dial has a 12 in. scale and the control has an infinite number of steps.

The driving motor is of the squirrel cage induction type with rotor overhung on the generator shaft. The rotor is die cast of aluminum, blowers being cast integral with the rotor bars. The stator core and coils form a pre-wound stator unit which is pressed into the frame. In case of a burnout, the old unit may be removed and another inserted to minimize delay. Stator coils are dual insulated with individually taped end turns. 220 volt sets may be reconnected for 440 volts and 440 volt sets may be reconnected for 220 volts by changing the motor connections at the conduit box as specified on the nameplate and by changing heaters on the circuit breaker. A "Nofuse" circuit breaker for motor operation is mounted within the welder frame.

For portable mounting, a three wheel design brings the machine close to the floor to lower the center of gravity and increase stability, and the machine is able to turn on a shorter radius.—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Thermostatic Mixing Valve

No. 619—New "Tempo" mixing valve with outlet temperatures adjustable from 120 to 160 F controls industrial process or domestic service hot water temperature. Hot water enters top of valve and cold water the side, the flow of both being controlled by a liquid operated thermostatic element. As the waters pass the inlet valves they are mixed in a chamber, then come in contact with the control element; unusually accurate control is made possible with mixing completed before the water contacts the thermostatic element, the maker states.

Outlet temperature is changed by removing cap on bottom of valve and turning screw. For good operation hot and cold water pressures must be nearly equal.—Excelso Products Corp., 65 Clyde Ave., Buffalo, N. Y.

Fuel Oil Heaters

No. 620—New fuel oil preheaters are available in three types—Type "O" for heavier oils, "D" for lighter oils and for installations where oil and steam pressures are lower than in industrial installations, and suction type heaters for installation in oil storage tanks to heat the oil as it is being withdrawn.

The Type "O" straight tube, multi-pass heaters are designed for either vertical or horizontal installation, and for 250 lb working oil pressure and 150 lb working steam pressure. Shells, tubes and tube sheets are of steel and rear head casting of semi-steel. The oil chamber is formed by an extension of the shell, which permits the oil connections to be made perpendicular to the length of the heater and by removing the bolted cover at the end, the tube ends are exposed without breaking any pipe lines; any tube may be removed without disturbing the others. This type is available in 22 sizes, capacity of the largest with 100 lb gage steam pressure and for a temperature range 90-200 F being 101,000 lb per hour of fuel oil and for temperature range 90-175 F, 139,500 lb.

The Type "D" U-tube heaters are adapted for installation below steam boiler water line, using the water as a heating medium and providing heated oil for the burners even though the boiler has been shut down for a long period. They are regularly built for working pressures up to 125 lb with steel shells, tubes and tube sheet, semi-steel oil chamber, and have removable heating section. The suction type heaters consist of a steel shell open at one end and with a flange near the opposite end for bolting or welding to the tank. Inside the shell are a number of U-shaped steel tubes through which steam flows, heating the oil in the shell surrounding the tubes and confining the heat to the oil being drawn. A cast iron steam chamber distributes steam to the tubes, and a suction opening is provided in the projecting end of the shell to which the pump suction is connected.—The Patterson-Kelley Co., East Stroudsburg, Pa.

Gear Motors and Speed Reducers

No. 621—New line of gear motors and speed reducers includes helical as well as worm gear drives, either direct connected or coupled type, in single, double, and triple reductions for horizontal, vertical, or right angle drive.

The helical gear motors are particularly adapted to drives which require ¾ to 75 hp and speeds down to 6 rpm when used with 1750 rpm motors. The worm gear motors are obtainable in power capacities from ¾ to 40 hp with speeds down to 30 rpm when used with 1750 rpm motors.—Diehl Mfg. Co., Elizabethport, N. J.

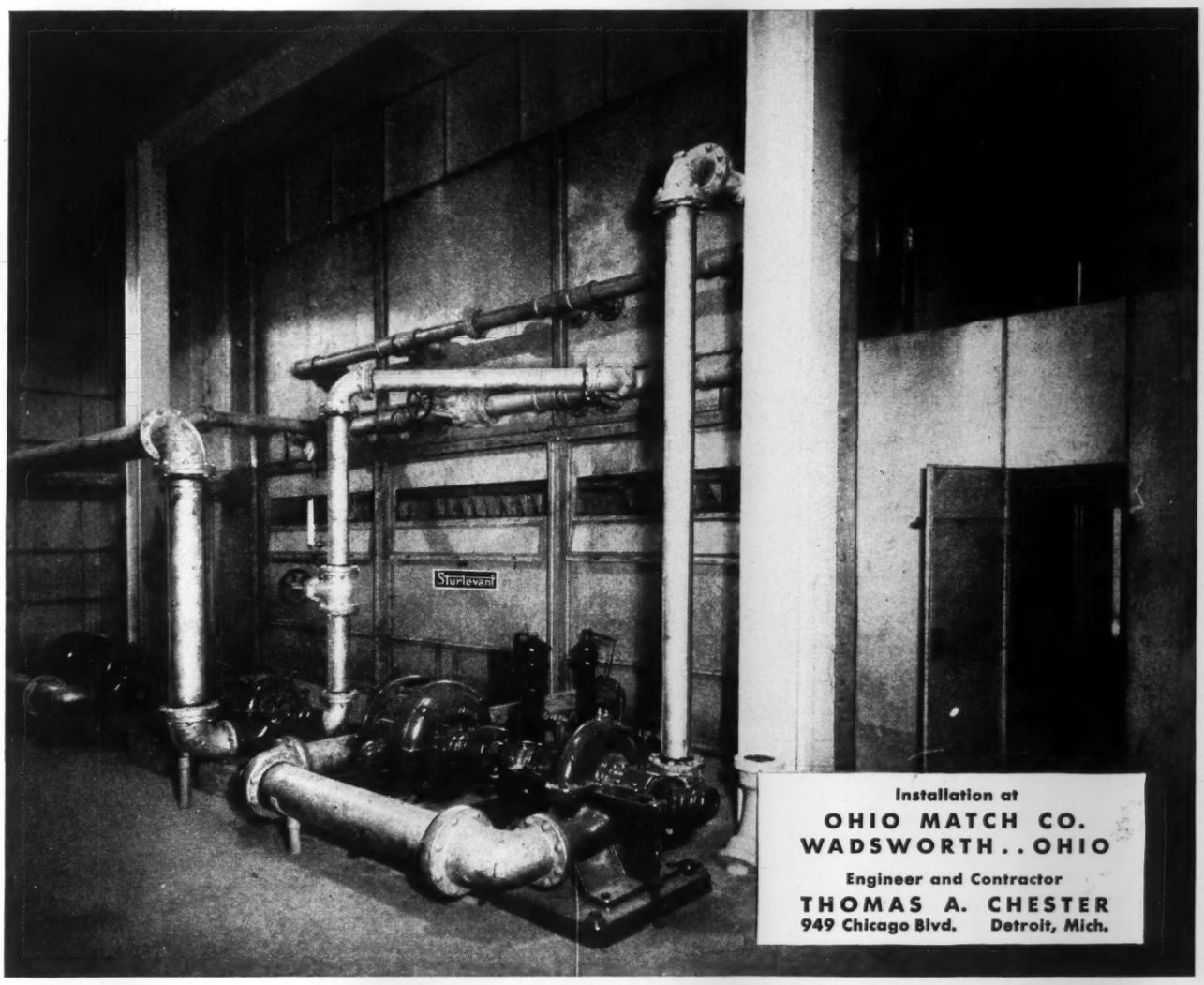
Self-Aligning Roller Bearing Units

No. 622—New "Series 400" line of anti-friction roller bearing units are equipped with "Shafer" double row roller bearings with self-aligning feature. Self-alignment is provided by concave

[*Continued on page 90, back section*]

STURTEVANT AIR WASHERS FOR INDUSTRIAL AIR CONDITIONING

(One of the Largest Dehumidifiers Ever Installed Shown Here)



32 feet wide...16 feet high...21 feet, 9 inches long! These are the dimensions of this Sturtevant Three-Stage, Double Deck Dehumidifying Air Washer installed at the Ohio Match Company, Wadsworth, Ohio.

Big job or small...you can get Sturtevant Air Conditioning or Ventilating Equipment to exactly meet any need...Fans, Air Washers, Heating Surface, Cooling Surface and Dehumidifiers ...individual units of equipment or complete systems. The most comprehensive variety of types and sizes available...the result of Sturtevant's 70 years of air engineering experience and constant product development.

We would welcome your inquiry for further information about any of this Sturtevant equipment in which you are interested.

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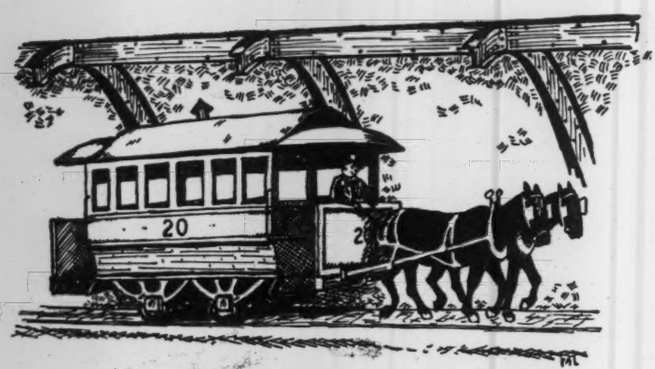

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NO, you wouldn't. But you *do* use horsepower in a subway—if you convey steam underground. The best assurance of your sub-surface steam reaching its destination at minimum cost, with minimum loss, is Ric-wiL Underground Conduit. Poorly engineered underground steam transmission is just as antique as a horse-car compared with a modern stream-lined train. Keep your lines, present or future, tight, dry, and permanently efficient with Ric-wiL.

Made in a variety of types, materials, and insulation methods (including the famous waterproof asbestos Ric-wiL Dry-paC), it secures satisfactory and economical results on *any* problem of underground steam transmission. Ric-wiL Systems are complete, including installation instructions and engineering service drawings, also supervision for the job if desired. Write for Bulletin 3503.

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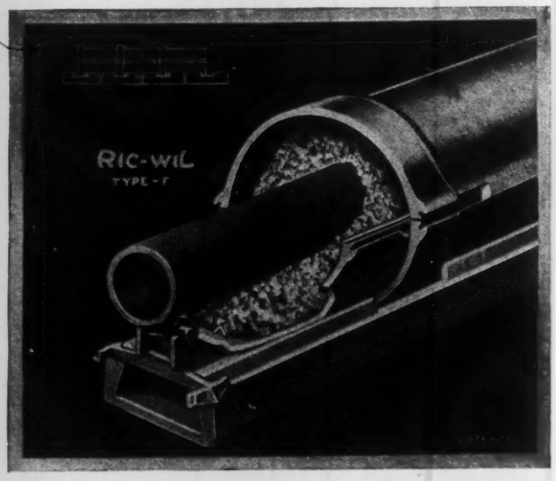

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·RIC-WIL·

CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

[*Continued from page 620, editorial section*]

rollers between convex outer races and a spherical inner race on the sleeve, which is free to deflect with a shaft temporarily mis-aligned or out of line because of installation inaccuracies. Labyrinth seals protect the bearings. Units are available for pillow blocks, flange bearings, hangers, and take-ups.—Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.

Electric Unit Heaters

No. 623—"Electromode" electric unit heaters, available in portable, built-in wall, and suspended industrial types, have cast in electric heating unit consisting of a helicoil sheath wire resistance heater element integral with an aluminum fin grid. Large convection surface of the units enables operation at low temperature, and units operate at maximum temperature of 250 F, states the manufacturer.—Electric Air Heater Co., Division of American Foundry Equipment Co., Mishawaka, Ind.

Portable Weld Testing Machine

No. 624—"Airco" portable tensile and bend testing machine enables testing welded specimens on the job. A direct load up to 40,000 lb can be applied, and by using specimens of smaller cross-sectional area than the maximum of 1½ in. by ½ in., loads equivalent to 150,000 lb per sq in. or higher can be applied. Large gage shows load, and an auxiliary pointer remains at point of maximum load. Readings are accurate to plus or minus 2 per cent, states the maker.

Machine consists of an oil pump, a hydraulically actuated piston or ram, two heads—one fixed and one movable—for gripping specimen, and four steel shafts, two of which transmit the piston motion and load to the movable head and the other two for maintaining alignment. By means of long lever attached to pump and ratio between areas of pump plunger and hydraulic ram, downward force on lever is magnified 400 times in the load applied to specimen. Entire unit—machine and case—weighs about 200 lb.

The same company has also recently announced a new heavy duty two-stage reduction regulator primarily designed to deliver large volumes of oxygen at relatively high pressures such as may be encountered on heavy cutting, deseaming jobs, furnace tapping and in similar operations. It finds its use principally where the oxygen demand is greater than can be handled by the conventional regulator, or where close pressure regulation and a low end point are desired. A further use of the regulator arises in cases where precise pressure regulation with medium flows is involved, and when the oxygen demand per regulator is in excess of 1000 to 1200 cu ft per hr.—Air Reduction Sales Co., Lincoln Bldg., New York, N. Y.

Push Button Master Switches

No. 625—New water tight push button master switches, mounted in molded phenolic compound enclosures, are intended for naval type installations or equivalent industrial applications. Each unit is operated by a molded compound lever to protect the operator from electrical contact with any metallic parts that might be alive, and as many as four units may be mounted in one enclosure. The units, designated as "CR2940" master switches, provide both normally open and closed circuits. Either momentary contact units or a combination of momentary contact and latched in units are available.—General Electric Co., Schenectady, N. Y.

Gas Fired Heaters

No. 626—New "Floorflo" heater, developed in conjunction with the Peoples Gas Light & Coke Co. of Chicago, adaptable to installation in apartments, stores, offices, factories, and homes.

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UNIT HEATERS

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6. Non-diaphragmatic Headers
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WHEN INSIDE SURFACES MUST BE CLEAN

Especially is this of vital importance in the smaller pipe sizes where the percentage of capacity may be materially decreased and small valves and instruments may be rendered useless by a small amount of foreign matter.

Fretz-Moon Pipe is as clean inside as outside—even in the smallest galvanized size. In its original form as skelp, at the beginning of the "continuous process," it is as clean as flat-rolled steel can be had. Throughout every phase of the "continuous process," this cleanliness is protected. Never once does the skelp come in contact with the furnace bottom where it may be contaminated by foreign matter. And when galvanized, the pipe is blown clean inside by superheated steam.

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BLACK AND GALVANIZED

Working parts consist of an all aluminum heat exchanger for high efficiency, burners, a safety pilot control valve, gas pressure regulator, and automatic supply valve, fans, motors, solenoid control valve, and a limit control switch which automatically cuts off the gas supply in the event of overheating from any cause. An automatic pilot switch prevents opening of the gas valve in the event of power failure. The cabinet has been expressly designed to closely resemble a piece of fine furniture, but the same unit without legs may be had in a suspended type for store and industrial installations.

A feature is the "Freeflo" grille which hides the interior of the unit and directs heat down to the floor line. The unit may also be equipped with humidifiers if desired. The smallest size unit has 35,000 Btu input capacity.—The Trane Co., LaCrosse, Wis.

Non-Clogging Centrifugal Pumping Units

No. 627—Open impeller non-clogging centrifugal pumps for handling solid materials in suspension, gritty liquids, liquid containing stringy material, etc., are made in a wide range of sizes, are of rigid "Monobloc" construction, and are compact, the greatest overall length of the largest size being 23 in.

Large size shaft, heavy duty grease lubricated ball bearings, rugged casings, stuffing box of ample depth arranged for water or independent seal, water thrower ring, splash proof motor, fan for air circulation, and protecting apron on motor are features of the design, states the maker.

Available in all iron, all bronze, or bronze fitted, and for special services in stainless steel, Everdur, and Monel metal. Ratings range from 10 to 250 gpm against heads of 10 to 100 ft; ½ hp to 7½ hp; 1500 rpm to 3600 rpm; ac or dc; 50 and 60 cycle; single phase or polyphase.—Worthington Pump and Machinery Corp., Harrison, N. J.

New Line of Control Valves

No. 628—New control or automatic shut-off valve available in sizes from ⅜ in. up embodies a number of features, among which are interchangeable elements for air control, steam pressure control, water pressure control or electrical control. Any one of these controls is connected by merely screwing it into the standard valve body mechanism. Valves can be adapted to automatic operation, to remote control, or to automatic operation plus an interlock with a manual reset device.

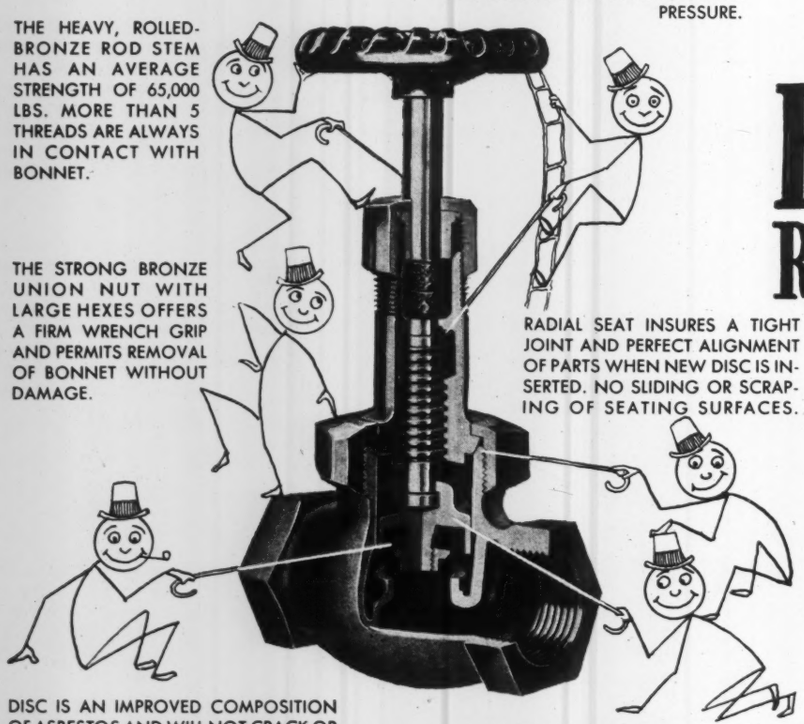
Valve itself has but two moving parts and is held in position, when closed, by a cadmium plated spring. Needle and seat are of stainless steel, and all other parts are also of non-corrosive metals. Ease of disassembly is a feature. The operating lever, actuated by the control device, transmits the force to lift the needle valve. A packless gland in the form of a brass bellows is used.

The interlock and manual reset device is a latch and weight arrangement which holds the valve in position after it has closed, until the weight has been reset manually. The air control mechanism is of the piston type. In the steam or hydraulic control, the pressure operates through a bellows. The electrical control of the valve is through an electro-magnet. May be used for remote control of oil, water, brine, etc.—Lammert & Mann Co., 281 N. Wood St., Chicago, Ill.

Machine Conditions Tobacco Leaves

No. 629—A new machine has been developed to condition the tobacco leaves that are used as wrapper in the manufacture of cigars. This is called "kasing," and consists of the introduction of water into the pores of the tobacco without changing the color of the leaves. The operation is usually manually performed.

The "Vellner" automatic kaser removes the human element and


PROTECTED TOP SEAT ASSURES A CLEAN TIGHT JOINT WHEN VALVE IS OPENED FOR RE-PACKING UNDER PRESSURE.
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RADIAL SEAT INSURES A TIGHT JOINT AND PERFECT ALIGNMENT OF PARTS WHEN NEW DISC IS INSERTED. NO SLIDING OR SCRAPING OF SEATING SURFACES.
DISC IS AN IMPROVED COMPOSITION OF ASBESTOS AND WILL NOT CRACK OR FLAKE OFF IN STEAM OR HOT OR COLD WATER SERVICE.
SLIDE-ON DISC HOLDER WILL NOT BIND OR STICK REGARDLESS OF POSITION OF VALVE. ANY STANDARD MAKE OF RINGS FIT THIS HOLDER.

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all tobacco treated in the machine is uniform in moisture content, free from spots or streaks and in the right state for the makers, the manufacturer states. No loss in breakage, increased yield, because of the uniformity of the wrapper, and retaining the original colors are features.

The machine requires only a girl to operate it. Similar in appearance to a commercial refrigerator, the unit has been designed along modernistic lines with a two-toned grey finish. A space of 6x12 ft is required with a ceiling height of 9 ft and as the wrapper comes out ready for stripping, the machine can be located on the same floor as the stripping machines.

The present machine has a capacity of 40 lb per hr of wrapper. A smaller machine having a capacity of 10 lb per hr is being designed.—Air Conditioning Corp., Detroit, Mich.

Steam Water Heater Electrically Controlled

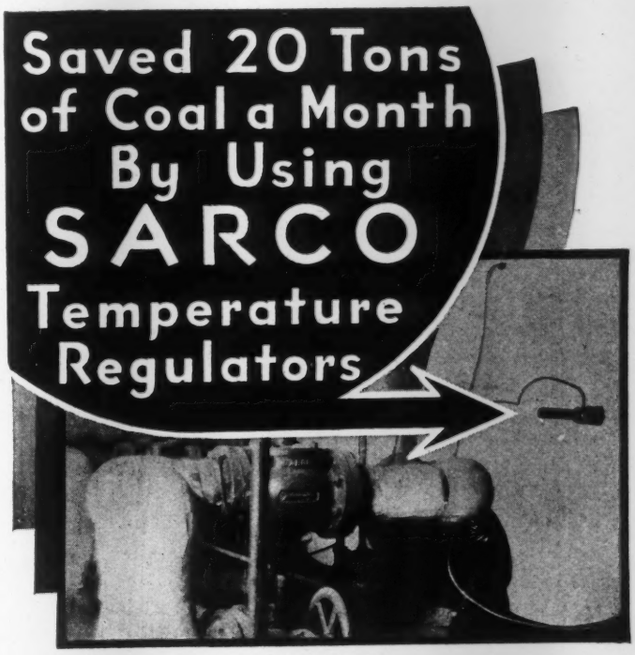
An electrically controlled steam water heater, utilizing a new system of heat transfer together with a new method of control and requiring no valves or other moving parts in the heat transfer system, has been developed by the General Electric Co.'s engineering laboratory. Although the device has not yet been placed in production as a new product manufactured by the company, installation tests now being made to determine acceptability, have shown promising results, according to the developer.

No steam regulating valve is used. The heat from the steam is released to the water by means of an hermetically sealed heat transfer system which utilizes water vapor as the heat carrying medium. The water vapor can be put into or removed from operation by an automatic electric means. In effect, therefore, heating is controlled by inserting or withdrawing the medium carrying the heat from the steam to the water—thus the release of heat from the steam rather than the steam flow itself is regulated.

The water heater is compact in size and simple in operation. It is made up essentially of three parts—a steam chamber, a water heating chamber, and the heat exchange system. The steam chamber and the water heating chamber, both cylindrical in form and both well insulated, are separated from each other, with the latter located directly above the former. Running between the two and extending well into them is a vapor tube, sealed at both ends but having a connection near the middle (between the two chambers) from which a pipe runs to an externally located, uninsulated heater reservoir. The vapor tube and heater reservoir comprise the heat transfer system, which contains no air and is hermetically sealed.

In the heater reservoir is a small amount of water and a cartridge type electric heating unit. The system is arranged so that when the heating unit is turned on and the water in the reservoir is heated sufficiently, vapor pressure forces the water up the pipe connected to the vapor tube. When the water strikes the hot part of the vapor tube extending into the steam chamber it is flashed into vapor which rises into the cool part of the tube extending into the water heating chamber. There the heat is given up to the water and the condensate runs back down the tube to be re-vaporized and to repeat the cycle, which is continuous until the water to be heated reaches the desired temperature.

When the water has been heated to the required point a thermostatic switch turns off the heating element in the heater reservoir. With the heating element off, the reservoir, being uninsulated, soon cools and the vapor pressure within it is correspondingly reduced. Thereupon the condensate from the water heating chamber, instead of returning to the steam chamber to be re-vaporized, is permitted to run back into the heater reservoir. Thus the heat carrier is removed from the vapor tube and no heat can be transferred from the steam chamber to the water heating chamber. For this reason the water in the upper chamber is not heated until the thermostatic switch turns on the heating unit and starts the whole process over again.



The superintendent of the large apartment at 308 East 79th St., New York, says that before Sarco Temperature Regulators were installed they were using three boilers, two for heating and one exclusively for hot water. Since the Sarco Regulators were put in on their storage water heaters they have been able to discontinue the use of the third boiler entirely.

The two boilers formerly used for heating alone are now also supplying all the steam needed for the hot water heaters and are doing so without requiring any more fuel than previously.

This means that they are saving between twenty and twenty-five tons of coal per month by the use of Sarco Temperature Regulators.

Thus Sarco Regulators quickly paid for themselves in fuel savings effected.

Once set for a certain temperature, Sarco Regulators hold that temperature without attention. They are inexpensive to install and maintain because no electricity, compressed air or water pressure is needed to operate.

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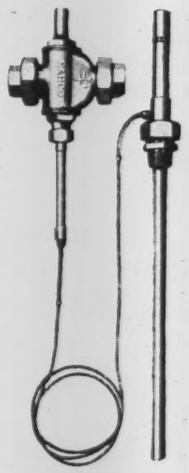

See our Exhibit at Booth 144, International Heating & Ventilating Exposition, Amphitheatre, Chicago, Ill., January 27th to 31st, 1936.

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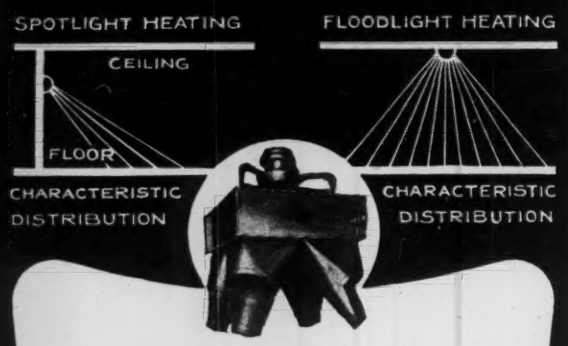

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Located in the ceiling, out of the way, it takes the air at the top of the building (preventing an accumulation of unprofitable heat) and forces it down to the floor area, through a number of perfectly distributed outlets, thereby covering completely the entire area to be heated.

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Schools and Study Courses

A combined course of home and shop training in refrigeration and air conditioning is being offered by the Refrigeration and Air Conditioning Institute, 2158 Lawrence Ave., Chicago, Ill.; it includes a series of lessons or work sheets expected to total 150 or more when entirely completed, a handbook comprising about 100 job tickets and 50 engineering data sheets, two weeks laboratory and shop training at the Institute on actual apparatus, transportation to and from the Institute, correction service, consultation service, vocational and employment service, lesson binders, diploma and miscellaneous supplies. The course has been endorsed by a number of prominent firms in the industry including American Radiator Co., Ilg Electric Ventilating Co., Kelvinator Corp., Westinghouse Electric and Mfg. Co., and others, and enjoys the advisory services of a group composed of men actively engaged in air conditioning and refrigeration work, according to the Institute.

The lessons for home study are divided into a number of sections which are sent to the student in the following order: Domestic refrigeration, commercial and industrial refrigeration, air conditioning homes and apartments, air conditioning stores and public buildings, air conditioning for plants and railroads, estimating costs, installation engineering, salesmanship, and the "business end" of refrigeration and air conditioning. These lessons emphasize installation and servicing, although considerable information is given on design. The lessons have been carefully prepared, are well illustrated, and are quite detailed.

The job tickets and data sheets are furnished to the student after he has completed the home study lessons. Pocket size, they comprise step by step instructions covering definite operations, such as making flared tubing connections, correcting sticking float valve, discharging refrigerant, adding refrigerant, etc. The data sheets give often referred to data, such as conversion tables, wire sizes, current ratings of motors, etc.

Following completion of home study sections of the course, the student is furnished motor coach transportation to Chicago for two weeks of laboratory and shop training working on standard equipment under the direction of instructors. The Institute expects to fully complete its laboratory and shops by March 1.

Conventions and Expositions

International Heating & Ventilating Exposition: January 27-31, International Amphitheater, Chicago, Ill. Manager, Charles F. Roth, Grand Central Palace, New York, N. Y.

American Society of Heating and Ventilating Engineers: Annual meeting, January 27-31, Palmer House Hotel, Chicago, Ill. Secretary, A. V. Hutchinson, 51 Madison Ave., New York, N. Y.

National Warm Air Heating and Air Conditioning Association: Winter meeting, January 27-29, Hotel Stevens, Chicago, Ill. Managing Director, A. W. Williams, A. I. U. Bldg., Columbus, Ohio.

Booklets, Reports and Papers

The Municipal Smoke Problem

"The Municipal Smoke Problem," by H. B. Meller and L. B. Sisson of the Mellon Institute of Industrial Research, Pittsburgh, Pa. 20 *pp.*, 4½x7 *in. Available upon request to the Institute.*

This interesting little booklet, written in non-technical style, discusses fuels and their composition, combustion and the way various fuels burn, products of combustion, effects of air pollutants, and concludes with a section on how to get cleaner city air by preventing the damaging products of combustion from getting into the atmosphere.

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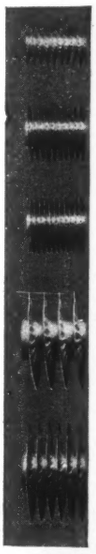

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Aerofin is years in advance of ordinary heating and cooling surface because of its exclusive features. It is available in aluminum, copper or other special metals. Whatever you have wished for in a fan system surface you will find in Aerofin.

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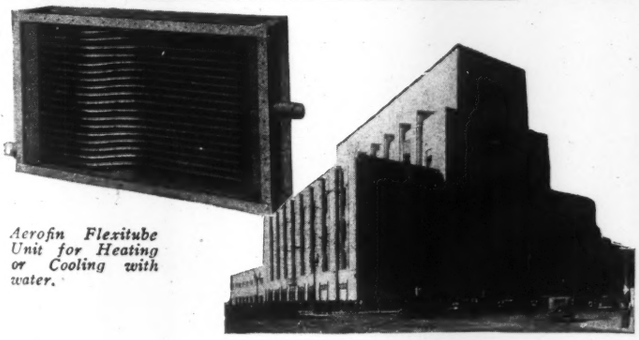

Aerofin Flexitube Unit for Heating or Cooling with water.

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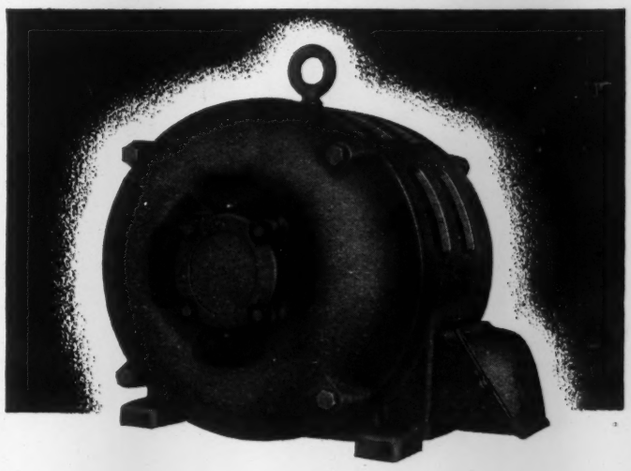

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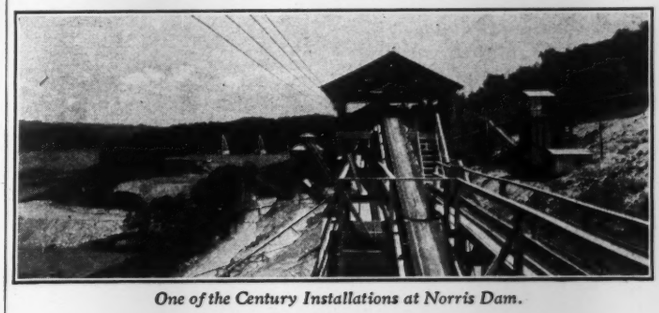

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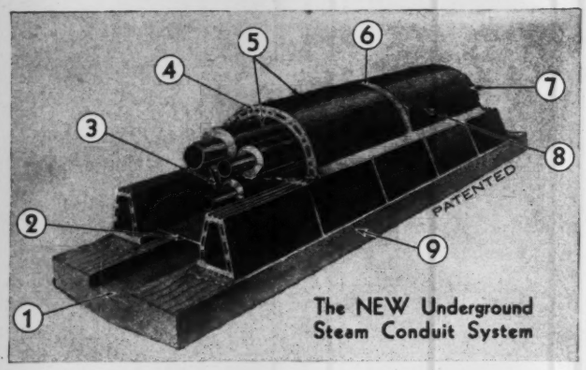

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2 Asbestos separator plate —supports fibre insulation when used.

3 Cast iron adjustable pipe supports for all pipe sizes and combinations. 12 ft. centers. Rest on concrete base.

4 Sealed air channels. Increase efficiency of insulating medium used.

5 Piping and conduit independently supported.

6 Waterproof mortar interlocks in channels and seals joints. Smooth exterior. Permits membrane waterproofing where desired.

7 Arched construction. Tests prove great strength.

8 Conduit may be opened without renewing parts.

9 Monolithic foundation poured on trench bottom. Convenient "sidewalk" for pipe contractor.

10 Thermal efficiency guaranteed, under test.

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Dallas: Johns-Manville Sales Corp.
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Canada—Montreal and Toronto: Canadian Johns-Manville Co., Ltd.

Embrittlement of Boilers

Bulletin No. 216 of the Engineering Experiment Station, University of Illinois, Urbana, entitled "Embrittlement of Boilers," by F. G. Straub, and originally issued in 1930 has been reprinted. Identical in form with the original, it covers causes of embrittlement, and gives methods of prevention. Copies are available from the Station for 85 cents.

Flow of Air in Mines

"The Resistance of Mine Timbers to the Flow of Air as Determined by Models," by C. M. Smith, Research Assistant Professor of Mining Engineering. Bulletin 279, issued by the Engineering Experiment Station, University of Illinois, Urbana. 64 pp., 6x9 in. Available upon application to the Station until April 1, or until the supply available for free distribution is exhausted.

The investigation described was undertaken to determine the resistance of different forms of mine timbering and to compare their effectiveness and economy as underground supports.

Cross bars were found to be the best type of timbering from the standpoint of air resistance, other comparable types developing from two to nearly six times the resistance of cross bars. Since, in many instances, the use of cross bars for roof support would effect a saving in timbering as well as in ventilating costs, their use would seem to be indicated, wherever feasible, in preference to props or 3-piece sets. Where air must be transmitted at considerable velocities through timbered entries, substantial savings will result from the use of peripheral timbering, and smooth-lining the passageway inside the timbers.

Pipe Welding Specifications; Bronze Welding

"Sample Pipe Welding Specifications," 8pp. 6x9 in.; "Bronze Welding or Hard Brazing of Cast Iron and Malleable Iron by the Oxy-Acetylene Process," 20 pp., 6x9 in. Both compiled and presented by the oxy-acetylene committee of the International Acetylene Association, 30 E. 42nd St., New York, N. Y.

The first-mentioned of these two booklets presents condensed specifications for welded piping to be incorporated by architects and engineers in general specifications. Specifications for heating, plumbing, refrigeration, air conditioning and process piping installations for pressures not to exceed 100 lb per sq in. and/or temperature not to exceed 406 F are given, as are specifications for power, refrigeration, air conditioning and process piping installations for pressures exceeding 100 lb per sq in.

The second pamphlet describes the theory of bronze welding, physical properties, discusses practice in some detail, and points out the applications, including the joining of pipe and bronze surfacing.

Book Reviews

Steam Plant Operation

"Steam Plant Operation," by E. B. Woodruff, Plant Engineer, The Union Gas and Electric Co., and H. B. Lammers, Test Engineer, The Union Gas and Electric Co., published by McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. 1st ed., 368 + ix pp., 5½x8¼ in., clothbound. $3.00.

With the object of assisting the practical man to secure a working knowledge of the principles of stationary engineering, the authors—each of whom is a licensed stationary engineer—present a combination of technical and practical information, including approved methods of operating equipment, rules of procedure to follow, and discuss progress and development in this field. Prac-

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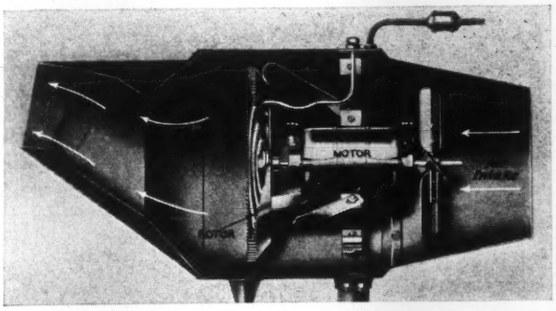

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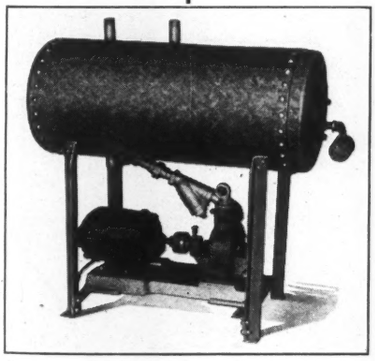

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For high or low pressure boilers . . . this unit pumps feed water against high boiler pressure . . . returns condensate to boiler . . . supplies make-up water as needed.

Operated electrically . . . it is entirely automatic in action and can be used with gas, oil, stoker or hand-fired boilers.

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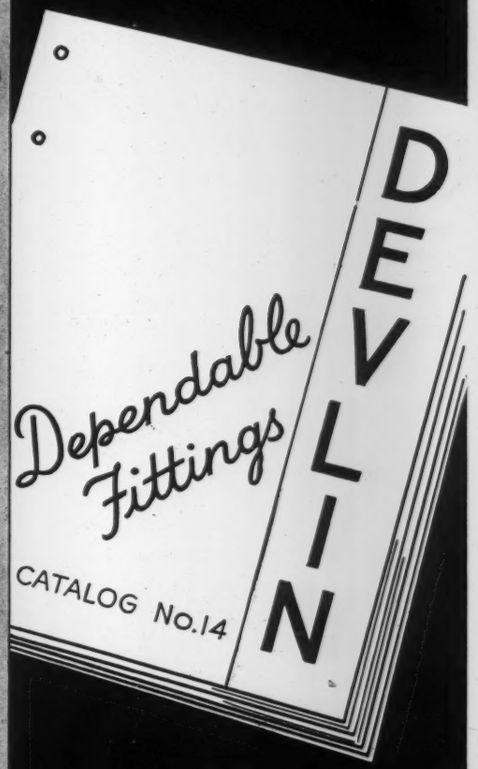

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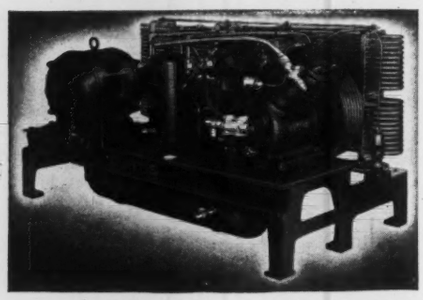

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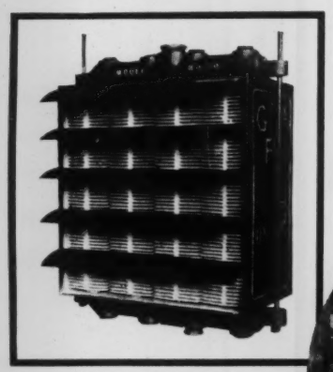

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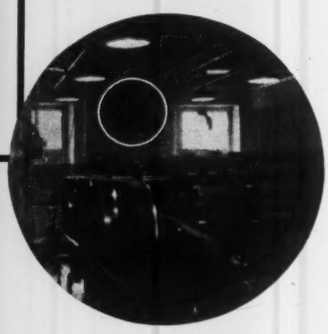

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tical power plant problems are solved without the use of involved mathematics, and the text is quite suitable for home study work or for technical school classes that require only a grammar school education.

Chapter headings comprise Boilers; Construction of Boilers; Combustion of Fuels; Settings, Combustion Equipment, and Heating Surfaces; Boiler Accessories; Operation and Maintenance of Steam Boilers; Construction of Steam Engines; Valve Operation Mechanism and Governors; Economic Operation of the Steam Engine; Operating Characteristics of the Steam Engine; Steam Turbine; Pumps; and Auxiliary Equipment. An appendix provides useful data.

Chemistry and Physics Handbook

"Handbook of Chemistry and Physics," edited by Charles D. Hodgman, Associate Professor of Physics, Case School of Applied Science. Published by Chemical Rubber Publishing Co., W. 112th St. and Locust Ave., Cleveland, O. 20th ed., 1950 + *xiv pp.,* 4½x6¾, *flexible binding.* $6.00.

The twentieth edition of this well known handbook follows the format of its predecessors, but includes new and revised data, most important of which is a table giving the physical constants of organic compounds. The book is divided into five sections of approximately equal length:—Mathematical Tables; Properties and Physical Constants; General Chemical Tables; Heat, Hygrometry, Sound, Electricity, and Light; and miscellaneous tables of quantities and units.

Mechanical and Electrical Equipment

"Mechanical and Electrical Equipment of Buildings," by Charles Merrick Gay, Professor of Architectural Construction, University of Pennsylvania, and Charles De Van Fawcett, Professor of Electrical Engineering, University of Pennsylvania. Published by John Wiley & Sons, Inc., 440 *Fourth Ave., New York, N. Y. 1st ed.,* 429 + *viii pp.,* 6x9 *in., clothbound.* $5.00.

With no pretense toward being a handbook of engineering design, this new book aims to give the architectural student and practicing architect an acquaintance with basic principles, for—as the authors point out in their preface—the architect and engineer must speak the same language.

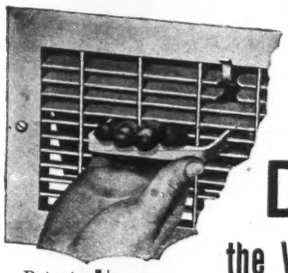
Section I covers water supply and Section II plumbing and drainage. The first five chapters of Section III are devoted to heating and the last two to air conditioning theory and design and application of air conditioning equipment. Electrical equipment is the subject of Section IV, and Section V is devoted to architectural acoustics.

Treatment of the subjects covered is quite complete and should be ample to achieve the book's object. A number of illustrative examples supplement the text.

Recent Trade Literature

For your convenience in obtaining copies of bulletins, see coupon on page 103.

No. 727. AIR CONDITIONING EQUIPMENT: Niagara Blower Co., 6 E. 45th St., New York, N. Y. Series of data sheets on surface coil type air conditioners for comfort air conditioning and saturating spray type conditioners for process air conditioning. Data sheet on fur preservation by air conditioning, showing recommended sizes. Bulletins on floor mounted all aluminum air conditioners of the spray cooler type, floor mounted and suspended fan cooler type air conditioners for use with ammonia, freon or brine; and motor blowers for ventilating, drying and other applications designed to simplify duct systems, and available in 7 sizes and 28 capacities for handling air up to resistance of 1 in. static pressure.



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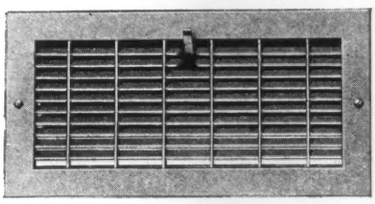

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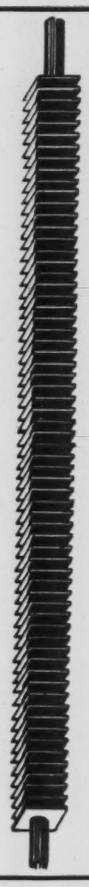
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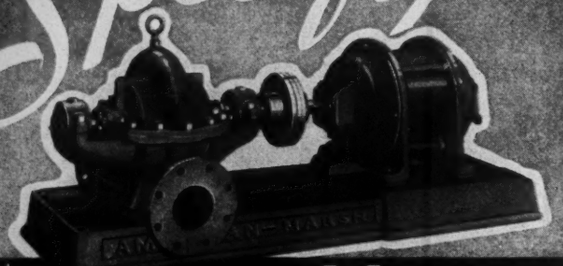
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No. 729. COMPRESSORS: Carbondale Machine Corp., Harrison, N. J. 6 p. bulletin describing refrigeration compressors of vertical duplex type, sizes 5 in. by 5 in. and smaller, equipped with feather valves. Construction is described and specifications and dimensions are given.

No. 730. GASKETS: Flexitallic Gasket Co., 8th & Bailey Sts., Camden, N. J. 14 p. catalog of various types of gaskets for pipe flanges, manholes and tube caps, describing features of design and giving specifications and prices.

No. 731. HEATING: C. A. Dunham Co., 450 E. Ohio St., Chicago, Ill. 464 p. pocket-size handbook on differential vacuum heating systems, low pressure steam heating systems, unit heaters and concealed radiators, other heating products, power plant and industrial service products and parts, with sections on the development of steam heating and heat control and engineering data. Numerous line drawings, tabular data, and specifications are given and a 7 p. cross-index facilitates use of information presented.

No. 732. METERING: Builders Iron Foundry, Providence, R. I. 8 p. bulletin on "Chronoflo" telemetering system for indicating or recording flow, pressure, level, temperature or position at any distance, describing the transmitting and receiving instruments and pointing out applications.

No. 733. MOTORS: Janette Mfg. Co., 556-558 W. Monroe St., Chicago, Ill. Leaflet briefly describing and illustrating this company's products, including direct and alternating current motors, motor generators, motorized speed reducers, motorized blowers, rotary convertors, oil transfer pumps, blower wheels, motor generators, etc.

No. 734. MOTORS: The Ohio Electric Mfg. Co., 5900 Maurice Ave., Cleveland, O. Series of data sheets giving outline dimensions for direct current and alternating current induction, fractional horsepower motors.

No. 735. OBSERVATION PORTS: National Radiator Corp., Johnstown, Pa. Sheet describing "Pyrex" glass observation ports for stoker, oil or gas fired boilers.

No. 736. PIPE: Republic Steel Corp., Youngstown, O. 16 p. booklet "The Greatest Pipe Show on Earth" listing and describing the various types of tubular products manufactured by this company and its subsidiary Steel and Tubes, Inc., and indexed for convenient use.

No. 737. PIPE HANGERS: Carpenter & Paterson, Inc., East Boston, Mass. Loose leaf catalog of "Witch" pipe hangers, supports, pipe covering protection saddles, radiator brackets and boiler hangers, and accessory equipment, giving descriptions and list prices.

No. 738. PRESSES: Niagara Machine & Tool Works, 637-697 Northland Ave., Buffalo, N. Y., 34 p. catalog of inclinable open back power presses used in the manufacture of sheet metal products, including refrigeration and air conditioning equipment. Details of construction are fully explained.

No. 739. PUMPS: Buffalo Pumps, Inc., 171 Mortimer St., Buffalo, N. Y. Two 16 p. booklets, one on close coupled single suction pumps, the other on double ball bearing single suction pumps, describing features of construction, giving specifications and presenting capacity tables.

No. 740. PUMPS: Worthington Pump & Machinery Corp., Harrison, N. J. 6 p. bulletin on horizontal duplex piston pumps for general services, turret type, for handling liquids at pressures up to 200 lb, giving specifications, sizes, capacities and dimensions.

No. 741. REFRACTORIES: Johns-Manville, 22 E. 40th St., New York, N. Y. 12 p. booklet entitled "Fire Tamers," telling in interesting manner the story of research and development of this company's refractory cements, briefly describing the various types and their applications.

No. 742. REFRIGERANTS: Virginia Smelting Co., West Norfolk, Va. Folder giving data in tabular form on methyl

chloride, sulphur dioxide and other refrigerants, including methods of testing for leaks and saturated vapor table.

No. 743. REFRIGERATION AND AIR CONDITIONING: Servel, Inc., Evansville, Ind. 6 p. folder describing features of this company's refrigeration and air conditioning equipment.

No. 744. REGULATING EQUIPMENT: Locke Regulator Co., Salem, Mass. Loose leaf bulletin of suggested applications of this company's regulating equipment, including hydraulic damper regulators for natural draft service; hydraulic regulators of adjustable compensated type; combination pressure regulators for reduced pressure, back pressure or relief; regulation for forced draft service; etc. Operation is explained and list prices are shown.

No. 745. STEAM JET REFRIGERATION: Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. 16 p. booklet on "Vac-Coolers" for supplying cold water for air conditioning and process cooling. Features are described, construction explained in detail, the cycle of operation described and ratings are given. Brewery and distillery applications are discussed and air conditioning installations in an office building and in a department store are illustrated and briefly described.

No. 746. UNIT HEATERS. National Radiator Corp., Johnstown, Pa. 8 p. bulletin giving detailed information on this company's unit heaters, including description of construction, applications, ratings and constants, dimensions, piping diagrams and pipe sizes.

No. 747. UNIT HEATERS: Surface Combustion Corp., Toledo, O. 8 p. issue of the "Janitrol Journal" devoted to gas fired unit heaters, describing their manufacture and including an article on surveys and layouts for unit heaters.

No. 748. UNIT HEATERS: L. J. Wing Mfg. Co., 14th St. & 7th Ave., New York, N. Y. 12 p. bulletin on unit heaters for general purpose heating, including engineering data and tables.

No. 749. UNIT HEATERS AND COOLERS: Niagara Blower Co., 6 E. 45th St., New York, N. Y. Bulletins on all aluminum disc fan heaters, disc fan heaters of the copper core type, and disc fan coolers for process and storage installations, giving dimensions, weights, ratings, describing applications and explaining construction details.

No. 750. VALVES: The Belknap Mfg. Co., Bridgeport, Conn. 16 p. catalog of bronze valves of various types and other heating and piping specialties, briefly describing them and giving list prices.

No. 751. VALVES: Homestead Valve Mfg. Co., Coraopolis, Pa. 4 p. folder briefly describing and illustrating plug valves, protected seat poppet type valves and seat and disc valves.

No. 752. VALVES AND FITTINGS: Mueller Brass Co., Port Huron, Mich. 72 p. catalog of valves, flared tube fittings, manifolds and strainers for air conditioning, refrigeration, gas, oil, air and vacuum lines showing exterior views and sections and giving detailed engineering specifications for each device.

No. 753. WATER METERS: Worthington-Gamon Meter Co., Harrison, N. J. 8 p. bulletin on disc water meters of split case type, giving general description and specifications for various models and including tables of capacities, dimensions and weights.

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Index to Advertisers

Firms represented in this issue are identified by the folio of the page on which their advertising appears. Advertising which appears in alternate issues is marked with an asterisk.

Aerofin Corp. 95
Allis-Chalmers Mfg. Co. ..... Inside Back Cover
American Air Filter Co., Inc. 24
American Blower Corp. ..... *
American Brass Co. 5
American District Steam Co. 102
American Radiator Company ..... *
American Steam Pump Co. 100
Anderson Company, The V. D. 103
Armstrong Cork Products Co. ..... 9 and 11
Armstrong Machine Works 20

Baker Ice Machine Co., Inc. 103
Bell & Gossett Co. ..... *
Binks Manufacturing Co. 102
Bridgeport Brass Co. 18
Bristol Company, The ..... *
Buffalo Forge Co. 25
Buffalo Pumps, Inc. 4
Burnham Boiler Corp. 88
Bush Manufacturing Co., The 100
Byers Co., A. M. ..... *

Carbondale Machine Corporation, Unit of Worthington Pump & Mchry. Corp. 105
Century Electric Co. 95
Clarage Fan Co. ..... *
Coppus Engineering Corp. ..... *
Crane Co. 106
Curtis Refrigerating Machine Co. 98

Dart Mfg. Co., E. M. 102
Dayton Rubber Mfg. Co., The ..... *
Delco Products Corp. ..... *
Detroit Lubricator Co. 14
Detroit Stoker Co. 6
Devlin Manufacturing Co., Thomas 97
Dole Valve Company, The ..... *
Dunham Company, C. A. ..... *

Electrimatic Corporation, The 99
Emerson Electric Mfg. Co. 19
Exposition Heating and Ventilating, 4th International ..... Back Cover

Fairbanks Co., The 92
Fedders Mfg. Co. 91
Fitzgibbons Boiler Company, Inc. 101
Foster Engineering Company 101
Fretz-Moon Tube Co., Inc. 91
Frick Company ..... *
Friez & Sons, Inc., Julien P. ..... *

G & O Mfg. Co., The 99
General Electric Co. 12
Grinnell Company, Inc. 3

Henry Furnace & Foundry Co., The 101
Hobart Brothers Co. ..... *
Hoffman Specialty Co., Inc. 8
Holtzer-Cabot Electric Co. 97

Ilg Electric Ventilating Co. ..... *
Independent Register & Mfg. Co. 99
International Engineering Co. 102

Jenkins Bros. ..... *
Johnson Service Co. ..... *

Kelvinator Corporation 17
Kinetic Chemicals, Inc. ..... *
Kuhns Brothers Co. ..... *

Lincoln Electric Co., The 87
Linde Air Products Co. 13

Mears-Kane-Ofeldt, Inc. 97
Milwaukee Valve Co. ..... *
Minneapolis-Honeywell Regulator Co. 101
Mueller Brass Co. 10
Mundet Cork Corporation ..... *
Myco Manufacturing Company 102

Nash Engineering Co. 30
National Tube Co. 26

Owens-Illinois Glass Co. ..... *
Oxweld Acetylene Co. 13

Penberthy Injector Co. ..... *
Porter & Co., H. W. 96
Powers Regulator Co., The ..... Inside Front Cover
Prest-O-Lite Company, Inc., The 13

Reading Iron Company 102
Republic Steel Corp. 28
Revere Copper and Brass, Incorporated 15
Ric-Wil Co., The 90

Sarco Co., Inc. 93
Staynew Filter Corp. ..... *
Streamline Pipe & Fittings Co. 10
Sturtevant Co., B. F. 89

Taylor Forge & Pipe Works 102
Taylor Instrument Companies ..... *
Titusville Iron Works Co., The 102
Trane Company, The 21
Tube-Turns, Inc. 23

Union Carbide and Carbon Corp. 13
Union Carbide Sales Co. 13
Unit Heater & Cooler Co. 98
U. S. Electrical Motors, Inc. ..... *

Wagner Electric Corp. ..... *
Walworth Company 7
Westinghouse Electric & Mfg. Co. ..... *
Wiegand Co., Edwin L. 99
Wing Mfg. Co., L. J. 94
Worthington Pump & Mchry. Corp. ..... *

Youngstown Sheet & Tube Co. 16

HEATING-PIPING AND AIR CONDITIONING'S

DIRECTORY

of

INDUSTRIAL and COMMERCIAL AIR CONDITIONING EQUIPMENT

SECTION

HOW TO USE THIS DIRECTORY

If you want to know the names of one or more manufacturers making a certain product, look in Section 1, where that product will appear in its proper place in the listing. If you have the trade name of a product and want to know who manufactures it, look in Section 2, where trade names are alphabetically listed. For the complete name and address of any manufacturer look in Section 3.

● The manufacturers whose names are spotted throughout the listings advertise their products in this issue. Turn to Index to Advertisers, page 136, for the page on which you will find the advertising of any of these manufacturers.

Editorial Section of
HEATING-PIPING AND AIR CONDITIONING
January, 1935
Chicago, Ill.

DIRECTORY

OF INDUSTRIAL AND COMMERCIAL AIR CONDITIONING EQUIPMENT SECTION

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ACTIVATED ALUMINA
See Adsorbents

ADSORBENTS (For dehumidifying)
Aluminum Company of America, Pittsburgh, Pa. (Activated Alumina)
Dow Chemical Co., Midland, Mich. (Calcium Chloride)
Research Corp., New York, N. Y. (Calcium Chloride)
Silica Gel Corp., Baltimore, Md. (Silica Gel)
United States Ozone Co. of America, Scottdale, Pa. (Dehydrated Calcium Chloride)

AIR CONDITIONING SYSTEMS
See Systems, Air Conditioning, Central, Comfort and Industrial

AIR CONDITIONING UNITS
See Unit Air Conditioners

AIR FILTERS
See Filters, Air

AIR WASHERS
See Washers, Air

ANEMOMETERS
● Friez & Sons, Inc., Julien P., Baltimore, Md.
Hill Co., E. Vernon, Chicago, Ill.
Taylor Instrument Companies, Rochester, N. Y.
Weston Electrical Instrument Co., Newark, N. J.

BALL BEARINGS
See Bearings, Ball

BASES, FAN
Armstrong Cork Products Co., Lancaster, Pa.
● Buffalo Forge Co., Buffalo, N. Y.
Diehl Mfg. Co., Elizabethport, N. J.
Dixie Mfg. Co., Inc., Baltimore, Md.
Firestone Tire & Rubber Co., Akron, O.
King Ventilating Co., Owatonna, Minn.
Korfund Co., Long Island City, N. Y. (Vibration isolating)
● Mundet Cork Corp., New York, N. Y.
United States Gypsum Co., Chicago, Ill.

BASES, MOTOR
Alexander Bros., Philadelphia, Pa. (Tension for short drives)
American Pulley Co., Philadelphia, Pa. (Tension for short drives)
Campbell Companies, E. K., Kansas City, Mo. (Vibration Isolating)
Diehl Mfg. Co., Elizabethport, N. J.
Firestone Tire & Rubber Co., Akron, O. (Vibration isolating)
● General Electric Co., Schenectady, N. Y. (All kinds)
Imperial Electric Co., Akron, O. (Sound proof)
Korfund Co., Long Island City, N. Y. (Vibration isolating)
Leland Electric Co., Dayton, O.
Lord Mfg. Co., Erie, Pa. (Vibration isolating)
Manhattan Rubber Mfg., Div. Raybestos-Manhattan, Inc., Passaic, N. J.
● Mundet Cork Corp., New York, N. Y. (Natural cork isolation mats)
Peerless Ice Machine Co., Chicago, Ill. (Pivoted)
Rockwood Mfg. Co., Indianapolis, Ind. (Pivoted-adjustable)
Smidth & Co., F. L., New York, N. Y. (Belt tension)
● Sturtevant Co., B. F., Boston, Mass.
United Cork Companies, Lyndhurst, N. J. (Vibration and isolation. Absorption material)
Union Fibre Co., Inc., Winona, Minn. (Vibration isolating)
United States Gypsum Co., Chicago, Ill. (Vibration isolating)
● Wagner Electric Corp., St. Louis, Mo.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. (Adjustable)

BEARINGS, BALL
Fafnir Bearing Co., New Britain, Conn.
Medart Co., St. Louis, Mo.
New Departure Mfg. Co., Bristol, Conn.
● Norma-Hoffmann Bearings Corp., Stamford, Conn.
Schatz Manufacturing Co., Poughkeepsie, N. Y.
Schwitzer-Cummins Co., Indianapolis, Ind.
SKF Industries, Inc., Philadelphia, Pa.

BEARINGS, ROLLER
Gatke Corp., Chicago, Ill.
Hyatt Roller Bearing Co., Harrison, N. J.
Medart Co., St. Louis, Mo.
● Norma-Hoffmann Bearings Corp., Stamford, Conn.
Randall Graphite Products Corp., Chicago, Ill.
Roller Bearing Co. of America, Trenton, N. J.
Schwitzer-Cummins Co., Indianapolis, Ind.
SKF Industries, Inc., Philadelphia, Pa.

BELT DRIVES
See Drives, Flat Belt and V Belt

BI-METALS, THERMOSTATIC
Chace Valve Co., W. M., Detroit, Mich.

BLOWERS
See Fans, Centrifugal

BLOWER WHEELS
See Wheels, Fan and Blower

CALCIUM CHLORIDE
See Adsorbents

CENTRAL AIR CONDITIONING SYSTEMS
See Systems, Air Conditioning, Central, Comfort and Industrial

CENTRIFUGAL COMPRESSORS
See Compressors, Refrigerating, Centrifugal

CHAIN DRIVES
See Drives, Chain

COILS
See Surface, Cooling and Heating

COMFORT AIR CONDITIONERS
See Unit Air Conditioners

COMPRESSORS, REFRIGERATING, CENTRIFUGAL
Carrier Engineering Corp., Newark, N. J.
DeLaval Steam Turbine Co., Trenton, N. J. (water vapor).
● Ingersoll-Rand, New York, N. Y. (water vapor)

COMPRESSORS, REFRIGERATING, RECIPROCATING
Airtemp, Inc., New York, N. Y.
American Engineering Co., Philadelphia, Pa.
● Baker Ice Machine Co., Inc., Omaha, Neb.
Bliss, E. W., Brooklyn, N. Y.
Brunner Mfg. Co., Utica, N. Y.
Builders Iron Foundry, Providence, R. I.
● Carbondale Machine Corp., Harrison, N. J.
Carrier Engineering Corp., Newark, N. J.
Copeland Refrigeration Corp., Mt. Clemens, Mich.
De La Vergne Engine Co., Philadelphia, Pa.
Fairbanks, Morse & Co., Chicago, Ill.
● Frick Co., Waynesboro, Pa.
Frigidaire Corp., Dayton, O.
● General Electric Co., Schenectady, N. Y.
General Refrigeration Sales Co., Beloit, Wis.
Howe Ice Machine Co., Chicago, Ill.
Ilg Electric Ventilating Co., Chicago, Ill.
● Ingersoll-Rand, New York, N. Y.
● Kelvinator Corp., Detroit, Mich.
Merchant & Evans Co., Philadelphia, Pa.
Nash Refrigeration Co., Inc., Newark, N. J.
Phoenix Ice Machine Co., Cleveland, O.
Reliance Refrigerating Machine Co., Chicago, Ill.

● Advertisement in this issue. See Index to Advertisers, page 136

Thermal Units Mfg. Co., Chicago, Ill.
Triumph Ice Machine Co., Cincinnati, O.
Universal Cooler Corp., Detroit, Mich.
U. S. Air Conditioning Corp., Minneapolis, Minn.
● Vilter Mfg. Co., Milwaukee, Wis.
Voss Ice Machine Wks., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
● Wittenmeier Machinery Co., Chicago, Ill.
Worthington Pump & Machinery Corp., Harrison, N. J.
XL Refrigerating Co., Chicago, Ill.
York Ice Machinery Co., York, Pa.

COMPRESSORS, REFRIGERATING, ROTARY

● Sturtevant Co., B. F., Boston, Mass.
● Vilter Mfg. Co., Milwaukee, Wis.

COMPRESSORS, REFRIGERATING, STEAM JET

● Carbondale Machine Corp., Harrison, N. J.
Carrier Engineering Corp., Newark, N. J.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Croll-Reynolds Co., Inc., New York, N. Y.
Elliott Co., Jeannette, Pa.
Foster Wheeler Corp., New York, N. Y.
● Ingersoll-Rand, New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.
Worthington Pump & Machinery Corp., Harrison, N. J.

CONDENSERS, REFRIGERATING

Airtemp, Inc., New York, N. Y.
Alco Products, Inc., New York, N. Y.
American Engineering Co., Philadelphia, Pa.
● Baker Ice Machine Co., Inc., Omaha, Neb.
● Carbondale Machine Corp., Harrison, N. J.
Carrier Engineering Corp., Newark, N. J.
De La Vergne Engine Co., Philadelphia, Pa.
● Fedders Mfg. Co., Inc., Buffalo, N. Y.
Foster Wheeler Corp., New York, N. Y.
● Frick Co., Waynesboro, Pa.
G. & O. Manufacturing Co., New Haven, Conn.
Howe Ice Machine Co., Chicago, Ill.
● Ingersoll-Rand, New York, N. Y.
● Kelvinator Corp., Detroit, Mich.
McCord Radiator & Mfg. Co., Detroit, Mich.
Reliance Refrigerating Machine Co., Chicago, Ill.
Rempe Co., Chicago, Ill.
Rome-Turney Radiator Co., Rome, N. Y.
● Sturtevant Co., B. F., Boston, Mass.
Thermal Units Mfg. Co., Chicago, Ill.
Trenton Auto Radiator Wks., Trenton, N. J.
Triumph Ice Machine Co., Cincinnati, O.
● Vilter Mfg. Co., Milwaukee, Wis.
Vogt Machine Co., Henry, Louisville, Ky.
Voss Ice Machine Wks., New York, N. Y.
● Wittenmeier Machinery Co., Chicago, Ill.
XL Refrigerating Co., Chicago, Ill.
Yates-American Machine Co., Beloit, Wis.
Young Radiator Co., Racine, Wis.

CONTROLS, ELECTRIC MOTOR

(Starters, switches, protective devices, relays, panels)

Allen-Bradley Co., Milwaukee, Wis.
● Allis-Chalmers Mfg. Co., Milwaukee, Wis.
● Automatic Products Co., Milwaukee, Wis.
Automatic Switch Co., New York, N. Y.
Bender Warrick Corp., Detroit, Mich.
● Bristol Co., Waterbury, Conn.
● Clark Controller Co., Cleveland, O.
Cutler-Hammer, Inc., Milwaukee, Wis.
● Detroit Lubricator Co., Detroit, Mich.
Eagle Signal Corp., Moline, Ill.
Electric Controller & Mfg. Co., Cleveland, O.
● Friez & Sons, Inc., Julien P., Baltimore, Md.
● General Electric Co., Schenectady, N. Y.
Hart Mfg. Co., Hartford, Conn.
● Holtzer-Cabot Electric Co., Boston, Mass.
Ideal Electric & Mfg. Co., Mansfield, O.
Mercoid Corp., Chicago, Ill.
● Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Paragon Electric Co., Chicago, Ill.
Penn Electric Switch Co., Des Moines, Ia.
Russell Electric Co., Chicago, Ill.
Sangamo Electric Co., Springfield, Ill.
Sheer Co., H. M., Quincy, Ill.
Square D Co., Milwaukee, Wis.
Stat-Amatic Instrument & Appliance Co., Hartford, Conn.
Struthers Dunn, Inc., Philadelphia, Pa.
Trumbull Electric Mfg. Co. Plainville, Conn.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CONTROLS, HUMIDITY

● Automatic Products Co., Milwaukee, Wis.
Automatic Temperature Control Co., Inc., Philadelphia, Pa.
Bahnson Co., Winston-Salem, N. C.
Barber-Colman Co., Rockford, Ill.
● Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
● Detroit Lubricator Co., Detroit, Mich.
Foxboro Co., Foxboro, Mass.
● Friez & Sons, Inc., Julien P., Baltimore, Md.
● General Electric Co., Schenectady, N. Y.
Grinnell Co., Inc., Providence, R. I.
H-B Instrument Co., Philadelphia, Pa.
Humidity Control Co., Tacoma, Wash.
International Moistening Co., Providence, R. I.
● Johnson Service Co., Milwaukee, Wis.
Johnson Tool Co., East Providence, R. I.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
Mason-Neilan Regulator Co., Boston, Mass.
● Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Monmouth Products Co., Cleveland, O.
National Regulator Co., Chicago, Ill.
Parks-Cramer Co., Fitchburg, Mass.
Penn Electric Switch Co., Des Moines, Ia.
Powers Regulator Co., Chicago, Ill.
Russell Electric Co., Chicago, Ill.
Somers, Inc., H. J., Detroit, Mich.
Standard Engineering Wks., Pawtucket, R. I.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
Taylor Instrument Companies, Rochester, N. Y.
Wilbin Instrument Corp., New York, N. Y.

CONTROLS, ROOM TEMPERATURE

● Alco Valve Co., Maplewood, St. Louis, Mo.
● Automatic Products Co., Milwaukee, Wis.
Automatic Temperature Control Co., Inc., Philadelphia, Pa.
Barber-Colman Co., Rockford, Ill.
● Bristol Co., Waterbury, Conn.
Central Heat Appliances, Chicago, Ill.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Cook Electric Co., Chicago, Ill.
● Detroit Lubricator Co., Detroit, Mich.
Englehardt, Inc., Chas., Newark, N. J.
Foxboro Co., Foxboro, Mass.
● Friez & Sons, Inc., Julien P., Baltimore, Md.
Fulton Sylphon Co., Knoxville, Tenn.
● General Electric Co., Schenectady, N. Y.
H-B Instrument Co., Philadelphia, Pa.
Illinois Engineering Co., Chicago, Ill.
Johnson Regulator Co., Emil T., Chicago, Ill.
● Johnson Service Co., Milwaukee, Wis.
Lawler Automatic Controls, Mt. Vernon, N. Y.
Mason-Neilan Regulator Co., Boston, Mass.
Mercoid Corp., Chicago, Ill.
● Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Monmouth Products Co., Cleveland, O.
National Regulator Co., Chicago, Ill.
Paragon Electric Co., Chicago, Ill.
Penn Electric Switch Co., Des Moines, Ia.
Pioneer Heat Regulator Corp., Dayton, O.
Powers Regulator Co., Chicago, Ill.
Russell Electric Co., Chicago, Ill.
● Sarco Co., New York, N. Y.
Sheer Co., H. M., Quincy, Ill.
Spencer Thermostat Co., Attleboro, Mass.
Superstat Co., Springfield, Mass.
Tagliabue Mfg., Co., C. J., Brooklyn, N. Y.
Taylor Instrument Companies, Rochester, N. Y.

Warren Webster Co., Camden, N. J.
Weston Electrical Instrument Co., Newark, N. J.
Wilbin Instrument Corp., New York, N. Y.

COOLING AND DEHUMIDIFYING UNITS

See Unit Air Conditioners

COOLING SURFACE

See Surface, Cooling, Brine, Cold Water, Direct Expansion

COOLING TOWERS

See Towers, Cooling

COUPLINGS, FLEXIBLE

● Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Bartlett Hayward Co., Baltimore, Md.
Boston Gear Works, Inc., North Quincy, Mass.
● Clark Controller Co., Cleveland, O.
Crocker-Wheeler Elec. Mfg. Co., Ampere, N. J.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Economy Pumping Machinery Co., Chicago, Ill.
Frederick Iron and Steel Co., Frederick, Md.
Lewis & Co., Chas. S., St. Louis, Mo.
Link-Belt Co., Chicago, Ill.
Medart Co., St. Louis, Mo.
Morse Chain Co., Ithaca, N. Y.
Poole Foundry & Machine Co., Baltimore, Md.
● Sturtevant Co., B. F., Boston, Mass.
Thermal Units Mfg. Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Whitney Mfg. Co., Hartford, Conn.
Zobell Electric Motor Corp., Garwood, N. J.

COUPLINGS, HYDRAULIC

American Blower Corp., Detroit, Mich.

COVERING, PIPE

Armstrong Cork Products Co., Lancaster, Pa.
Carey Co., Philip, Lockland, Cincinnati, O.
Cork Import Corp., New York, N. Y.
Cork Insulation Co., New York, N. Y.
Eagle-Picher Sales Co., Cincinnati, O.
Ehret Magnesia Mfg. Co., Valley Forge, Pa.
● General Insulating & Mfg. Co., Alexandria, Ind.
Johns-Manville, New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Mineral Felt Co., Toledo, O.
● Mundet Cork Corp., New York, N. Y.
National Asbestos Mfg. Co., Jersey City, N. J.
Norristown Magnesia & Asbestos Co., Norristown, Pa.
Ruberoid Co., New York, N. Y.
Sall Mountain Co., Chicago, Ill.
Standard Lime & Stone Co., Baltimore, Md.
Union Fibre Co., Inc., Winona, Minn.
United Cork Companies, Lyndhurst, N. J.

DAMPER MOTORS

See Motors, Damper

DAMPER QUADRANTS AND ACCESSORIES

American Foundry & Furnace Co., Bloomington, Ill.
Hart & Cooley Mfg. Co., Chicago, Ill.
King Ventilating Co., Owatonna, Minn.
Parker-Kalon Corp., New York, N. Y.
Young Ventilating Co., Cleveland, O.

DAMPER REGULATORS

See Regulators, Damper

DAMPERS, DUCT

American Foundry & Furnace Co., Bloomington, Ill.
Brown, Wm. P., Springfield, Mass.
● Clarage Fan Co., Kalamazoo, Mich.
Hart & Cooley Mfg. Co., Chicago, Ill.
Jordan & Co., Paul R., Indianapolis, Ind.
● Johnson Service Co., Milwaukee, Wis.
King Ventilating Co., Owatonna, Minn.
Kirk & Blum Mfg. Co., Cincinnati, O.
National Regulator Co., Chicago, Ill.
Niagara Blower Co., New York, N. Y.
Powers Regulator Co., Chicago, Ill.
Tuttle & Bailey, Inc., New Britain, Conn.
Uni-Flo Corp., Detroit, Mich.

DEHUMIDIFIERS, ADSORPTION

Ozone Pure Airifier Co., Chicago, Ill.
Pittsburgh Lectrodryer Corp., Pittsburgh, Pa.
Research Corp., New York, N. Y.
Silica Gel Corp., Baltimore, Md.
Somers, Inc., H. J., Detroit, Mich.

DEHUMIDIFIERS, SPRAY

American Blower Corp., Detroit, Mich.
Bayley Blower Co., Milwaukee, Wis.
Bishop & Babcock Sales Co., Cleveland, O.
● Buffalo Forge Co., Buffalo, N. Y.
Campbell Companies, E. K., Kansas City, Mo.
Carrier Engineering Corp., Newark, N. J.
● Clarage Fan Co., Kalamazoo, Mich.
Kauffman Air Conditioning Corp., St. Louis, Mo.
King Ventilating Co., Owatonna, Minn.
Niagara Blower Co., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Somers, Inc., H. J., Detroit, Mich.
● Sturtevant, Co., B. F., Boston, Mass.
Super-Aire Conditioning Corp., St. Louis, Mo.
Trane Co., La Crosse, Wis.
U. S. Air Conditioning Corp., Minneapolis, Minn.

DEHUMIDIFIERS, SURFACE

American Blower Corp., Detroit, Mich.
● Baker Ice Machine Co., Inc., Omaha, Neb.
Frigidaire Corp., Dayton, O.
● General Electric Co., Schenectady, N. Y.
Ilg Electric Ventilating Co., Chicago, Ill.
● Kelvinator Corp., Detroit, Mich.
King Ventilating Co., Owatonna, Minn.
McCord Radiator & Mfg. Co., Detroit, Mich.
Nesbitt Inc., John J., Philadelphia, Pa.
Somers, Inc., H. J., Detroit, Mich.
Strang Air Conditioning Corp., Kansas City, Mo.
● Sturtevant, Co., B. F., Boston, Mass.
Thermal Units Mfg. Co., Chicago, Ill.
U. S. Air Conditioning Corp., Minneapolis, Minn.
Unit Heater & Cooler Co., Wausau, Wis.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
● Wing Mfg. Co., L. J., New York, N. Y.
● Wittenmeier Machinery Co., Chicago, Ill.
X L Refrigerating Co., Chicago, Ill.
Young Radiator Co., Racine, Wis.

DIAPHRAGM VALVES

See Valves, Diaphragm

DIFFUSERS

American Foundry & Furnace Co., Bloomington, Ill.
Auer Register Co., Cleveland, O.
● Bush Mfg. Co., Hartford, Conn.
Campbell Companies, E. K., Kansas City, Mo.
Carrier Engineering Corp., Newark, N. J.
Frigidaire Corp., Dayton, O.
Humidi-Cooler Corp., West Haven, Conn.
Niagara Blower Co., New York, N. Y.
Super-Aire Conditioning Corp., St. Louis, Mo.
Trane Co., La Crosse, Wis.
Trenton Auto Radiator Wks., Trenton, N. J.
U. S. Air Conditioning Corp., Minneapolis, Minn.
WAJ Manufacturing Co., Kansas City, Mo.
Waterloo Register Co., Waterloo, Ia.
Young Radiator Co., Racine, Wis.

DOORS AND PANELS, ACCESS

American Foundry & Furnace Co., Bloomington, Ill.
Auer Register Co., Cleveland, O.
● Clarage Fan Co., Kalamazoo, Mich.
Higgin Mfg. Co., Newport, Ky.
Kane Mfg. Co., Kane, Pa.
Kirk & Blum Mfg. Co., Cincinnati, O.
Rock Island Register Co., Rock Island, Ill.
● Sturtevant Co., B. F., Boston, Mass.
Tuttle & Bailey, Inc., New Britain, Conn.
Way Panel Loctor Co., Wollaston, Mass.

DRIVES, CHAIN

Boston Gear Works, Inc., North Quincy, Mass.
Chain Belt Co., Milwaukee, Wis.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.
Ramsey Chain Co., Inc., Albany, N. Y.
Whitney Mfg. Co., Hartford, Conn.

DRIVES, FLAT BELT

Alexander Bros., Philadelphia, Pa.
American Pulley Co., Philadelphia, Pa.
Boston Woven Hose & Rubber Co., Cambridge, Mass.
● Carbondale Machine Corp., Harrison, N. J.
Chicago Belting Co., Chicago, Ill.
Gates Rubber Co., Denver, Colo.
Gilmer Co., L. H., Philadelphia, Pa.
Graton & Knight, Worcester, Mass.
Houghton & Co., E. F., Philadelphia, Pa.
Manhattan Rubber Mfg., Div. Raybestos-Manhattan, Inc., Passaic, N. J.
Medart Co., St. Louis, Mo.
Republic Rubber Co., Youngstown, O.
Rhoads & Sons, J. E., Philadelphia, Pa.
Rockwood Mfg. Co., Indianapolis, Ind.
Thermoid Rubber Co., Trenton, N. J.
U. S. Rubber Co., New York, N. Y.

DRIVES, V BELT

● Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Pulley Co., Philadelphia, Pa.
Boston Gear Works, Inc., North Quincy, Mass.
● Carbondale Machine Corp., Harrison, N. J.
Chicago Belting Co., Chicago, Ill.
Dayton Rubber Mfg. Co., Dayton, O.
Dodge Mfg. Co., Mishawaka, Ind.
Fairbanks, Morse & Co., Chicago, Ill.
Firestone Tire & Rubber Co., Akron, O.
Gates Rubber Co., Denver, Colo.
Gilmer Co., L. H., Philadelphia, Pa.
Horton Mfg. Co., Minneapolis, Minn.
Jones Foundry Machine Co., W. A., Chicago, Ill.
Manhattan Rubber Mfg., Div. Raybestos-Manhattan, Inc., Passaic, N. J.
Medart Co., St. Louis, Mo.
Republic Rubber Co., Youngstown, O.
Rockwood Mfg. Co., Indianapolis, Ind.
Sterling Electric Motors, Inc., Los Angeles, Cal.
Thermoid Rubber Co., Trenton, N. J.
Worthington Pump & Machinery Corp., Harrison, N. J.

DUCT DAMPERS

See Dampers, Duct

DUCT THERMOSTATS

See Thermostats, Duct

EJECTORS, STEAM

See Compressors, Refrigerating, Steam Jet

ENGINES, STEAM

● Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Blower Corp., Detroit, Mich.
● Clarage Fan Co., Kalamazoo, Mich.
Elliott Co., Jeannette, Pa.
Erie City Iron Wks., Erie, Pa.
● Frick Co., Waynesboro, Pa.
Harrisburg Fdry. & Mach. Co., Inc., Harrisburg, Pa.
Leffel & Co., James, Springfield, O.
Morris Machine Wks., Baldwinsville, N. Y.
Murray Iron Wks., Burlington, Ia.
Orr & Sembower, Inc., Reading, Pa.
Skinner Engine Co., Erie, Pa.
● Sturtevant Co., B. F., Boston, Mass.
Troy Engine & Machine Wks., Troy, Pa.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

EXPANSION VALVES

See Valves, Expansion, Refrigerating

FAN AND BLOWER WHEELS

See Wheels, Fan and Blower

FAN BASES

See Bases, Fan

FANS, CENTRIFUGAL

Allen Billmyre Corp., New York, N. Y.
American Blower Corp., Detroit, Mich.
American Coolair Corp., Jacksonville, Fla.
American Foundry & Furnace Co., Bloomington, Ill.
Autoforce Ventilating System, Boston, Mass.
Autovent Fan & Blower Co., Chicago, Ill.
Bayley Blower Co., Milwaukee, Wis.
Bishop & Babcock Sales Co., Cleveland, O.
● Buffalo Forge Co., Buffalo, N. Y.
Campbell Companies, E. K., Kansas City, Mo.
Champion Blower & Forge Co., Lancaster, Pa.
● Clarage Fan Co., Kalamazoo, Mich.
Columbus Heating & Ventilating Co., Columbus, O.
Coppus Engineering Corp., Worcester, Mass.
Diehl Mfg. Co., Elizabethport, N. J.
Dixie Mfg. Co., Inc., Baltimore, Md.
Duriron Co., Inc., Dayton, O. (acid resisting).
Electrovent Fan & Mfg. Co., Chicago, Ill.
● Emerson Electric Mfg. Co., St. Louis, Mo.
Garden City Fan Co., Chicago, Ill.
Ilg Electric Ventilating Co., Chicago, Ill.
Janette Mfg. Co., Chicago, Ill.
King Ventilating Co., Owatonna, Minn.
Kleenaire Corp., Stevens Point, Wis.
Lehigh Fan & Blower Co., Allentown, Pa.
Pangborn Corp., Hagerstown, Md.
Russell Electric Co., Chicago, Ill.
Schwitzer-Cummins Co., Indianapolis, Ind.
Scott Ballantyne Co., Omaha, Neb.
● Sturtevant Co., B. F., Boston, Mass.
Super-Aire Conditioning Corp., St. Louis, Mo.
● Torrington Mfg. Co., Torrington, Conn.
Typhoon Air Conditioning Co., New York, N. Y.
U. S. Air Conditioning Corp., Minneapolis, Minn.
● Wing Mfg. Co., L. J., New York, N. Y.

FANS, PROPELLER

Aerovent Fan Co., Piqua, O.
Aircraft Mfg. Co., Dayton, O.
Airmaster Corp., Chicago, Ill.
American Blower Corp., Detroit, Mich.
American Coolair Corp., Jacksonville, Fla.
Autovent Fan & Blower Co., Chicago, Ill.
Belco Exhaust Fan Mfg. Co., St. Louis, Mo.
Bendix Products Corp., South Bend, Ind.
● Buffalo Forge Co., Buffalo, N. Y.
Campbell Companies, E. K., Kansas City, Mo.
Champion Blower & Forge Co., Lancaster, Pa.
● Clarage Fan Co., Kalamazoo, Mich.
Coppus Engineering Corp., Worcester, Mass.
Dallas Engineering Corp., Dallas, Tex.
Davenport Mfg. Co., Meadville, Pa.
De Bothezat Corp., New York, N. Y.
Diehl Mfg. Co., Elizabethport, N. J.
Dixie Mfg. Co., Inc., Baltimore, Md.
Electrovent Fan & Mfg. Co., Chicago, Ill.
● Emerson Electric Mfg. Co., St. Louis, Mo.
Garden City Fan Co., Chicago, Ill.
● General Electric Co., Schenectady, N. Y.
Hartzell Propeller Fan Co., Piqua, O.
Ilg Electric Ventilating Co., Chicago, Ill.
International Engineering, Inc., Dayton, O.
King Ventilating Co., Owatonna, Minn.
Marathon Electric Mfg. Corp. Wausau, Wis.
Meier Electric & Machine Co., Indianapolis, Ind.
Myers Electric Co., Pittsburgh, Pa.
Peerless Electric Co., Warren, O.
Perkins & Son, Inc., B. F., Holyoke, Mass.
Propellair, Inc., Springfield, O.
Russell Electric Co., Chicago, Ill.
Schwitzer-Cummins Co., Indianapolis, Ind.
● Sturtevant Co., B. F., Boston, Mass.
● Torrington Mfg. Co., Torrington, Conn.
Typhoon Air Conditioning Co., New York, N. Y.
U. S. Air Conditioning Corp., Minneapolis, Minn.
Vallen, Inc., Akron, O.
● Wagner Electric Corp., St. Louis, Mo.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
● Wing Mfg. Co., L. J., New York, N. Y.

FILTERS, AIR, AUTOMATIC

● American Air Filter Co., Inc., Louisville, Ky.
Burt Air Filter Corp., New York N. Y.
Coppus Engineering Corp., Worcester, Mass.
Dracco Corp., Cleveland, O.
Hugo Mfg. Co., West Duluth, Minn.
Independent Air Filter Co., Chicago, Ill.

FILTERS, AIR, UNIT, DRY

● American Air Filter Co., Inc., Louisville, Ky.
American Foundry & Furnace Co., Bloomington, Ill.
Burt Air Filter Corp., New York N. Y.
Consolidated Air Conditioning Corp., New York, N. Y.
Coppus Engineering Corp., Worcester, Mass.
Davies Air Filter Co., New York, N. Y.
Dracco Corp., Cleveland, O.
Greene Gas Cleaner Co., Cleveland, O.
Hugo Mfg. Co., West Duluth, Minn.
Independent Air Filter Co., Chicago, Ill.
Kleenaire Corp., Stevens Point, Wis.
Russell Electric Co., Chicago, Ill.
Somers Air Filter Sales Co., Detroit, Mich.
● Staynew Filter Corp., Rochester, N. Y.

FILTERS, AIR, UNIT, VISCOUS

● American Air Filter Co., Inc., Louisville, Ky.
American Radiator Co., New York, N. Y.
Humidity Control Co., Tacoma, Wash.
Independent Air Filter Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
Kleenaire Corp., Stevens Point, Wis.
● Owens-Illinois Glass Co., Toledo, O.
Russell Electric Co., Chicago, Ill.

FITTINGS, COPPER TUBE

● American Brass Co., Waterbury, Conn.
American Radiator Co., New York, N. Y.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Chase Brass & Copper Co., Waterbury, Conn.
● Hays Mfg. Co., Erie, Pa.
● Mueller Brass Co., Port Huron, Mich.
Northern Indiana Brass Co., Elkhart, Ind.
Parker Appliance Co., Cleveland, O.
● Revere Copper & Brass, Inc., New York, N. Y.
Scovill Mfg. Co., Waterbury, Conn.
● Streamline Pipe & Fittings Co., Port Huron, Mich.
● Walworth Co., New York, N. Y.

FITTINGS, PIPE, BRASS

Acheson Mfg. Co., Rankin, Pa.
American Manganese Bronze Co., Philadelphia, Pa.
Belfield & Co., H., Philadelphia, Pa.
Chase Brass & Copper Co., Waterbury, Conn.
● Crane Co., Chicago, Ill.
Detroit Brass & Malleable Wks., Detroit, Mich.
Devlin Mfg. Co., Thos., Burlington, N. J.
Grabler Mfg. Co., Cleveland, O.
Grinnell Co., Inc., Providence, R. I.
Illinois Malleable Iron Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Jenkins Mfg. Co., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Kerotest Mfg. Co., Pittsburgh, Pa.
Lunkenheimer Co., Cincinnati, O.
● Mueller Brass Co., Port Huron, Mich.
Oberdorfer Brass Co., M. L., Syracuse, N. Y.
Parker Appliance Co., Cleveland, O.
Phoenix Brass Fittings Corp., Irvington, N. J.
Pittsburgh Valve & Fittings Co., Barberton, O.
Powell Co., Wm., Cincinnati, O.
Rhode Island Fittings Co., Hillsgrove, R. I.
● Walworth Co., New York, N. Y.
Zurn Mfg. Co., J. A., Erie, Pa.

FITTINGS, PIPE, CAST IRON

● Crane Co., Chicago, Ill.
Detroit Brass & Malleable Wks., Detroit, Mich.
Devlin Mfg. Co., Thos., Burlington, N. J.
Grabler Mfg. Co., Cleveland, O.
Grinnell Co., Inc., Providence, R. I.
Illinois Malleable Iron Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Valve & Fittings Co., Barberton, O.
Stockham Pipe & Fittings Co., Birmingham, Ala.
● Walworth Co., New York, N. Y.
Zurn Mfg. Co., J. A., Erie, Pa.

FITTINGS, PIPE, MALLEABLE

● Crane Co., Chicago, Ill.
● Dart Mfg. Co., E. M., Providence, R. I. (Unions)
Detroit Brass & Malleable Wks., Detroit, Mich.
Devlin Mfg. Co., Thos., Burlington, N. J.
Dresser Mfg. Co., S. R., Bradford, Pa.
Grabler Mfg. Co., Cleveland, O.
Grinnell Co., Inc., Providence, R. I.
Illinois Malleable Iron Co., Chicago, Ill.
Jarecki Mfg. Co., Erie, Pa.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Malleable Iron Fittings Co., Branford, Conn.
Pittsburgh Valve & Fittings Co., Barberton, O.
Rhode Island Fittings Co., Hillsgrove, R. I.
Semler Co., Jeannette, Pa.
Stockham Pipe & Fittings Co., Birmingham, Ala.
● Walworth Co., New York, N. Y.
Zurn Mfg. Co., J. A., Erie, Pa.

FITTINGS, PIPE, WELDING

Bonney Forge & Tool Wks., Allentown, Pa.
● Crane Co., Chicago, Ill.
Grinnell Co., Inc., Providence, R. I.
Midwest Piping & Supply Co., St. Louis, Mo.
Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.
● Taylor Forge & Pipe Wks., Chicago, Ill.
Tube-Turns, Inc., Louisville, Ky.
● Walworth Co., New York, N. Y.

FLEXIBLE COUPLINGS

See Couplings, Flexible

GAGES

Bacharach Industrial Instrument Co., Pittsburgh, Pa. (Draft)
● Bristol Co., Waterbury, Conn. (Recording, controlling, and indicating)
Brown Instrument Co., Philadelphia, Pa. (Indicating, recording, controlling)
● Clark Controller Co., Cleveland, O. (Pressure, vacuum)
Ellison Draft Gage Co., Chicago, Ill. (Draft)
Esterline-Angus Co., Indianapolis, Ind. (Recording, electrical and pressure)
Foxboro Co., Foxboro, Mass. (Indicating and recording pressure gages, ammonia gages, etc.)
Hays Corp., Michigan City, Ind. (Indicating and controlling draft, pressure and differential draft and pressure)
Hill Co., E. Vernon, Chicago, Ill. (Filter)
Keckley Co., O. C., Chicago, Ill. (Water)
Mercoid Corp., Chicago, Ill. (Pressure, vacuum)
Moto Meter Gauge & Equipment Corp., La Crosse, Wis. (Vacuum & pressure recording)
Scientific Instrument Co., Detroit, Mich. (Mercury-U-Tube type)
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y. (Recording)
United States Gauge Co., New York, N. Y. (Pressure, vacuum, compound, retard, recording)

GRILLES

Aircraft Mfg. Co., Dayton, O.
American Coolair Corp., Jacksonville, Fla.
American Foundry & Furnace Co., Bloomington, Ill.
Auer Register Co., Cleveland, O.
Best Register Co., Milwaukee, Wis.
Campbell Companies, E. K., Kansas City, Mo.
Cross Engineering Co., Carbondale, Pa.
Diamond Mfg. Co., Wyoming, Pa.
Erdle Perforating Co., Rochester, N. Y.
Harrington & King Perforating Co., Chicago, Ill.
Hart & Cooley Mfg. Co., Chicago, Ill.
Hendrick Mfg. Co., Carbondale, Pa.
● Independent Register & Mfg. Co., Cleveland, O.
Knowles Mushroom Ventilator Co., New York, N. Y.
Metalace Corp., So. Boston, Mass.
Register & Grille Mfg. Co., Brooklyn, N. Y.
Rock Island Register Co., Rock Island, Ill.
Symonds Register Co., St. Louis, Mo.
Tuttle & Bailey, Inc., New Britain, Conn.
Uni-Flo Corp., Detroit, Mich.
U. S. Air Conditioning Corp., Minneapolis, Minn.
United States Register Co., Battle Creek, Mich.

WAJ Manufacturing Co., Kansas City, Mo.
Waterloo Register Co., Waterloo, Ia.
Wickwire Spencer Steel Co., New York, N. Y.

HEATING SURFACE
See Surface, Heating, Ferrous and Non-Ferrous

HUMIDIFYING AND HEATING UNITS
See Unit Air Conditioners

HUMIDIFYING SYSTEMS
See Systems, Humidifying, Direct and Indirect

HUMIDITY CONTROLS
See Controls, Humidity

HUMIDITY INDICATING INSTRUMENTS
See Hygrometers and Psychrometers

HUMIDITY RECORDERS
See Recorders, Humidity

HYDRAULIC COUPLINGS
See Couplings, Hydraulic

HYGROMETERS
Amthor Testing Instrument Co., Brooklyn, N. Y.
● Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Dusinberre Indicator Co., Kew Gardens, N. Y.
Fee and Stemwedel, Inc., Chicago, Ill.
Foxboro Co., Foxboro, Mass.
● Friez & Sons, Inc., Julien P., Baltimore, Md.
H-B Instrument Co., Philadelphia, Pa.
Humidity Control Co., Tacoma, Wash.
International Moistening Co., Providence, R. I.
Johnson Tool Co., East Providence, R. I.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
Mason-Neilan Regulator Co., Boston, Mass.
Parks-Cramer Co., Fitchburg, Mass.
Philadelphia Thermometer Co., Philadelphia, Pa.
Standard Air Conditioning, Inc., New York, N. Y.
Standard Engineering Wks., Pawtucket, R. I.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
Taylor Instrument Companies, Rochester, N. Y.

INDICATING THERMOMETERS
See Thermometers, Indicating

INDUSTRIAL AIR CONDITIONERS
See Unit Air Conditioners

INSULATION, BUILDING
Alfol Insulation Co., New York, N. Y. (Aluminum foil).
Alton Mineral Wool Co., Alton, Ill.
American Flange & Mfg. Co., Inc., New York, N. Y. (Metal sheets).
American Hair & Felt Co., Chicago, Ill. (Hair felt).
Armstrong Cork Products Co., Lancaster, Pa. (Corkboard; fibreboard).
Blom-Gamarra Humidifier, New York, N. Y. (Aerated gypsum).
Cabot, Inc., Samuel, Boston, Mass. (Flexible quilt).
Celotex Co., Chicago, Ill.
Cork Import Corp., New York, N. Y. (Cork).
Cork Insulation Co., Inc., New York, N. Y. (Corkboard).
Cornell Wood Products Co., Chicago, Ill.
Eagle-Picher Sales Co., Cincinnati, O.
Ehret Magnesia Mfg. Co., Valley Forge, Pa. (Cork, wool, felt).
Fir-Tex Insulating Board Co., St. Helens, Ore. (Wood fibre board).
● General Insulating & Mfg. Co., Alexandria, Ind. (Rock wool).
General Insulating Products Co., Brooklyn, N. Y. (Rock wool).
Insulite Co., Minneapolis, Minn. (Board type).
International Vermiculite Co., Springfield, Ill. (Loose fill).
Johns-Manville, New York, N. Y. (Rock wool & wood fibre board).
Keasbey & Mattison Co., Ambler, Pa. (Asbestos).
Masonite Corp., Chicago, Ill.
Mineral Felt Co., Toledo, O. (Loose fill).
● Mundet Cork Corp., New York, N. Y. (Corkboard).
Norristown Magnesia & Asbestos Co., Norristown, Pa.
Reynolds Metals Co., New York, N. Y. (Aluminum foil).
Sprayo-Flake Co., Milwaukee, Wis.
Standard Lime & Stone Co., Baltimore, Md.
Stewart Inso Board Corp., St. Joseph, Mo. (Board form semi-rigid).
Union Fibre Co., Inc., Winona, Minn. (Quilted, semi-rigid, loose, granulated, blanket & jacket types, rock wool).
United Cork Companies, Lyndhurst, N. J. (Cork).
United States Gypsum Co., Chicago, Ill. (Wool and board).
Upson Co., Lockport, N. Y. (Flexible, rigid insulating board).
Wood Conversion Co., St. Paul, Minn. (Board and blanket).

INSULATION, DUCT AND SPRAY CHAMBER
Alfol Insulation Co., New York, N. Y. (Aluminum foil).
American Flange & Mfg. Co., Inc., New York, N. Y. (Metal sheets).
American Hair & Felt Co., Chicago, Ill. (Hair felt).
Armstrong Cork Products Co., Lancaster, Pa. (Corkboard; fibreboard).
Cabot, Inc., Samuel, Boston, Mass. (Flexible quilts).
Carey Co., Philip, Lockland, O., (Asbestos).
Cork Import Corp., New York, N. Y. (Cork).
Cork Insulation Co., Inc., New York, N. Y. (Corkboard).
Eagle-Picher Sales Co., Cincinnati, O.
Ehret Magnesia Mfg. Co., Valley Forge, Pa. (Cork).
Fir-Tex Insulating Board Co., St. Helens, Ore. (Wood fibre board).
● General Insulating & Mfg. Co., Alexandria, Ind. (Rock wool).
General Insulating Products Co., Brooklyn, N. Y. (Rock wool).
Insulite Co., Minneapolis, Minn. (Board type).
International Vermiculite Co., Springfield, Ill. (Block).
Johns-Manville, New York, N. Y. (Rock cork).
Keasbey & Mattison Co., Ambler, Pa. (Asbestos).
Masonite Corp., Chicago, Ill.
Mineral Felt Co., Toledo, O.
● Mundet Cork Corp., New York, N. Y. (Corkboard).
Norristown Magnesia & Asbestos Co., Norristown, Pa.
Ruberoid Co., New York, N. Y. (Magnesia & asbestos).
Sall Mountain Co., Chicago, Ill. (Asbestos).
Standard Lime & Stone Co., Baltimore, Md.
Stewart Inso Board Corp., St. Joseph, Mo. (Board form semi-rigid).
Union Fibre Co., Inc., Winona, Minn. (Semi-rigid, blanket and jacket, block form, rock wool).
United Cork Companies, Lyndhurst, N. J. (Cork).

INSULATION, SOUND
American Hair & Felt Co., Chicago, Ill. (Hair felt)
Armstrong Cork Products Co., Lancaster, Pa. (Cork acoustical treatment)
Blom-Gamarra Humidifier, New York, N. Y. (Aerated gypsum)
Burgess Battery Co., Madison, Wis. (Acoustic duct lining)
Cabot, Inc., Samuel, Boston, Mass (Flexible quilt)
Celotex Co., Chicago, Ill.
Cork Import Corp., New York, N. Y.
Cork Insulation Co., Inc., New York, N. Y.
Cornell Wood Products Co., Chicago, Ill.
Eagle-Picher Sales Co., Cincinnati, O.
Ehret Magnesia Mfg. Co., Valley Forge, Pa. (Cork and hair felt)
Fir-Tex Insulating Board Co., St. Helens, Ore. (Insulating board)
● General Insulating & Mfg. Co., Alexandria, Ind. (Rock wool)
General Insulating Products Co., Brooklyn, N. Y. (Acoustic rock wool)
Insulite Co., Minneapolis, Minn. (Board type)
Johns-Manville, New York, N. Y. (Rock wool, hair felt)
Keasbey & Mattison Co., Ambler, Pa. (Asbestos)
Korfund Co., Long Island City, N. Y. (Vibration isolation)
Masonite Corp., Chicago, Ill.
Maxim Silencer Co., Hartford, Conn. (Silencer)
Mineral Felt Co., Toledo, O.
● Mundet Cork Corp., New York, N. Y.
Stewart Inso Board Corp., St. Joseph, Mo. (Semi-rigid tile)
Union Fibre Co., Inc., Winona, Minn. (Block form, sheet form, quilted, rock wool)
United Cork Companies, Lyndhurst, N. Y.
United States Gypsum Co., Chicago, Ill. (Machine bases. Wall & Ceiling)
Wood Conversion Co., St. Paul, Minn. (Board and blanket)

IONIZATION APPARATUS

Montgomery Bros., San Francisco, Cal.
Ozone Pure Airifier Co., Chicago, Ill.
Russell Electric Co., Chicago, Ill.
United States Ozone Co. of America, Scottdale, Pa.

ISOLATION, SOUND AND VIBRATION

See Insulation, Sound; Bases, Fan; Bases, Motor

LOUVERS

Airmaster Corp., Chicago, Ill.
American Foundry & Furnace Co., Bloomington, Ill.
Autovent Fan & Blower Co., Chicago, Ill.
Best Register Co., Milwaukee, Wis.
Burt Manufacturing Co., Akron, O.
Campbell Companies, E. K., Kansas City, Mo.
Champion Blower & Forge Co., Lancaster, Pa.
Diehl Mfg. Co., Elizabethport, N. J.
Electrovent Fan & Mfg. Co., Chicago, Ill.
Jordan & Co., Paul R., Indianapolis, Ind.
Kirk & Blum Mfg. Co., Cincinnati, O.
Kleenaire Corp., Stevens Point, Wis.
Powers Regulator Co., Chicago, Ill.
Robertson Co., H. H., Pittsburgh, Pa.
United States Register Co., Battle Creek, Mich.
WAJ Manufacturing Co., Kansas City, Mo.
Waterloo Register Co., Waterloo, Ia.

MECHANICAL DRIVE TURBINES

See Turbines, Mechanical Drive

MOTOR BASES

See Bases, Motor

MOTOR CONTROLS

See Controls, Electric Motor

MOTORS, ELECTRIC, FRACTIONAL HP

Allis Co., Louis, Milwaukee, Wis.
Baldor Electric Co., St. Louis, Mo.
Brown-Brockmeyer Co., Dayton, O.
● Century Electric Co., St. Louis, Mo.
● Delco Products Corp., Dayton, O.
Diehl Mfg. Co., Elizabethport, N. J.
Dumore Co., Racine, Wis.
● Emerson Electric Mfg. Co., St. Louis, Mo.
Fairbanks, Morse & Co., Chicago, Ill.
● General Electric Co., Schenectady, N. Y.
● Holtzer-Cabot Electric Co., Boston, Mass.
Howell Electric Motors Co., Howell, Mich.
Imperial Electric Co., Akron, O.
Janette Mfg. Co., Chicago, Ill.
Leland Electric Co., Dayton, O.
Lincoln Electric Co., Cleveland, O.
Marathon Electric Mfg. Corp., Wausau, Wis.
Master Electric Co., Dayton, O.
Ohio Electric Mfg. Co., Cleveland, O.
Peerless Electric Co., Warren, O.
Robbins & Meyers Co., Springfield, O.
Russell Electric Co., Chicago, Ill.
● Sturtevant Co., B. F., Boston, Mass.
● Wagner Electric Corp., St. Louis, Mo.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

MOTORS, ELECTRIC, INTEGRAL HP

● Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Allis Co., Louis, Milwaukee, Wis.
Baldor Electric Co., St. Louis, Mo.
Brown-Brockmeyer Co., Dayton, O.
● Century Electric Co., St. Louis, Mo.
Continental Electric Co., Inc., Newark, N. J.
Crocker-Wheeler Elec. Mfg. Co., Ampere, N. J.
● Delco Products Corp., Dayton, O.
Diehl Mfg. Co., Elizabethport, N. J.
Elliott Co., Jeannette, Pa.
● Emerson Electric Mfg. Co., St. Louis, Mo.
Fairbanks, Morse & Co., Chicago, Ill.
● General Electric Co., Schenectady, N. Y.
Harnischfeger Corp., Milwaukee, Wis.
● Holtzer-Cabot Electric Co., Boston. Mass.
Howell Electric Motors Co., Howell, Mich.
Ideal Electric & Mfg. Co., Mansfield, O.
Imperial Electric Co., Akron, O.
Janette Mfg. Co., Chicago, Ill.
Leland Electric Co., Dayton, O.
Lincoln Electric Co., Cleveland, O.
Marble-Card Electric Co., Gladstone, Mich.
Master Electric Co., Dayton, O.
Peerless Electric Co., Warren, O.
Reliance Electric & Engineering Co., Cleveland, O.
Robbins & Meyers Co., Springfield, O.
Star Electric Motor Co., Bloomfield, N. J.
● Sturtevant Co., B. F., Boston, Mass.
Triumph Ice Machine Co., Cincinnati, O.
● Wagner Electric Corp., St. Louis, Mo.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Zobell Electric Motor Corp., Garwood, N. J.

MOTOR OPERATED VALVES

See Valves, Motor-Operated

MOTOR STARTERS

See Controls, Electric Motor

MOTORS, DAMPER

● Automatic Products Co., Milwaukee, Wis.
Automatic Temperature Control Co., Inc., Philadelphia, Pa.
Barber-Colman Co., Rockford, Ill.
Bishop & Babcock Sales Co., Cleveland, O.
Cook Electric Co., Chicago, Ill.
● Detroit Lubricator Co., Detroit, Mich.
● Friez & Sons, Inc., Julien P., Baltimore, Md.
Fulton Sylphon Co., Knoxville, Tenn.
● Johnson Service Co., Milwaukee, Wis.
Master Electric Co., Dayton, O.
● Minneapolis-Honeywell Regulator Co. Minneapolis, Minn.
Monmouth Products Co., Cleveland, O. (Hydraulic)
National Regulator Co., Chicago, Ill.
Niagara Blower Co., New York, N. Y.
Pioneer Heat Regulator Corp., Dayton, O.
Powers Regulator Co., Chicago, Ill.
Russell Electric Co., Chicago, Ill.
Sheer Co., H. M., Quincy, Ill.
● Wagner Electric Corp., St. Louis, Mo.
Wilbin Instrument Corp., New York, N. Y.

MUSHROOM VENTILATORS

See Ventilators, Mushroom

NOZZLES, SPRAY, AIR WASHER

American Blower Corp., Detroit, Mich.
Bayley Blower Co., Milwaukee, Wis.
● Binks Mfg. Co., Chicago, Ill.
● Buffalo Forge Co., Buffalo, N. Y.
● Clarage Fan Co., Kalamazoo, Mich.
Cooling Tower Co., Inc., New York, N. Y.
● Detroit Lubricator Co., Detroit, Mich.
Johnson Tool Co., East Providence, R. I.
Kant Klog Nozzle Co., Kansas City, Mo.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
Marley Co., Kansas City, Mo.
Martocello & Co., Jos. A., Philadelphia, Pa.
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Parks-Cramer Co., Fitchburg, Mass.
Penn Spray Tower Wks., Pittsburgh, Pa.
Spray Engineering Co., Somerville, Mass.
● Sturtevant Co., B. F., Boston, Mass.
Trane Co., La Crosse, Wis.
U. S. Air Conditioning Corp., Minneapolis, Minn.
Yarnall-Waring Co., Philadelphia, Pa.

NOZZLES, SPRAY, COOLING TOWER

● Binks Mfg. Co., Chicago, Ill.
● Buffalo Forge Co., Buffalo, N. Y.
Burhorn Co., Edwin, Hoboken, N. J.
● Clarage Fan Co., Kalamazoo, Mich.
Cooling Tower Co.. Inc., New York, N. Y.
● Detroit Lubricator Co., Detroit, Mich.
Marley Co., Kansas City, Mo.
Martocello & Co., Jos. A., Philadelphia, Pa.
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Niagara Blower Co., New York, N. Y.
Penn Spray Tower Wks., Pittsburgh, Pa.
● Schubert-Christy Corp., St. Louis, Mo.
Spray Engineering Co., Somerville, Mass.

Wheeler Mfg. Co., C. H., Philadelphia, Pa.
Yarnall-Waring Co., Philadelphia, Pa.

OZONE APPARATUS

Hydrozone Co., Inc., New York, N. Y.
Montgomery Bros., San Francisco, Cal.
Ozone Pure Airifier Co., Chicago, Ill.
Triox Engineering Co., St. Louis, Mo.
United States Ozone Co. of America, Scottdale, Pa.

PANELS, CONTROL

See Controls, Electric Motor

PARTS, PRESSED SHEET METAL

● American Brass Co., Waterbury, Conn.
Berger Mfg. Co., Canton, O.
Bossert Corp., Utica, N. Y.
Geuder, Paeschke & Frey Co., Milwaukee, Wis.
Martin-Parry Corp., York, Pa.
U. S. Pressed Steel Products Co., Kalamazoo, Mich.
Youngstown Pressed Steel Co., Warren, O.

PIPE, BRASS AND COPPER

● American Brass Co., Waterbury, Conn.
American Radiator Co., New York, N. Y.
American Tube Wks., New York, N. Y.
Baltimore Tube Co., Baltimore, Md.
Bridgeport Brass Co., Bridgeport, Conn.
Chase Brass & Copper Co., Waterbury, Conn.
● Mueller Brass Co., Port Huron, Mich.
● Revere Copper & Brass, Inc., New York, N. Y.
Scovill Mfg. Co., Waterbury, Conn.
● Streamline Pipe & Fittings Co., Port Huron, Mich.

PIPE, CAST IRON, THREADED

American Cast Iron Pipe Co., Birmingham, Ala.
American Radiator Co., New York, N. Y.
Somerville Iron Wks., Somerville, N. J.
● Walworth Co., New York, N. Y.

PIPE, WROUGHT IRON

● Byers Co., A. M., Pittsburgh, Pa.
Cohoes Rolling Mill Co., Cohoes, N. Y.
● Reading Iron Co., Philadelphia, Pa.

PIPE, WROUGHT STEEL

Bethlehem Steel Co., Bethlehem, Pa.
Central Tube Co., Pittsburgh, Pa.
● Fretz-Moon Tube Co., Butler, Pa.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
National Tube Co., Pittsburgh, Pa.
Pittsburgh Tube Co., Pittsburgh, Pa.
● Republic Steel Corp., Youngstown, O.
South Chester Tube Co., Chester, Pa.
Spang, Chalfant & Co., Pittsburgh, Pa.
● Taylor Forge & Pipe Wks., Chicago, Ill. (Spiral riveted)
Wheeling Steel Corp., Wheeling, W. Va.
● Youngstown Sheet & Tube Co., Youngstown, O.

PRESSED SHEET METAL PARTS

See Parts, Pressed Sheet Metal

PRESSURE REGULATORS

See Regulators, Pressure

PSYCHROMETERS

● Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Foxboro Co., Foxboro, Mass.
● Friez & Sons, Inc., Julien P., Baltimore, Md.
Hill Co., E. Vernon, Chicago, Ill.
● Johnson Service Co., Milwaukee, Wis.
Mason-Neilan Regulator Co., Boston, Mass.
Parks-Cramer Co., Fitchburg, Mass.
Philadelphia Thermometer Co., Philadelphia, Pa.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.

PSYCHROSTATS

See Controls, Humidity

PUMPS, BRINE CIRCULATING

● Allis-Chalmers Mfg. Co., Milwaukee, Wis.
● American Steam Pump Co., Battle Creek, Mich.
● Ames Pump Co., Inc., New York, N. Y.
Buffalo Pumps, Inc., Buffalo, N. Y.
Chicago Pump Co., Chicago, Ill.
Davidson Co., M. T., New York, N. Y.
Dayton-Dowd Co., Quincy, Ill.
Decatur Pump Co., Decatur, Ill.
De Laval Steam Turbine Co., Trenton, N. J.
Deming Co., Salem O.
Economy Pumping Mchry. Co., Chicago, Ill.
Fairbanks, Morse & Co., Chicago, Ill.
Foster Pump Works, Inc., Brooklyn, N. Y.
Frederick Iron and Steel Co., Frederick, Md.
Goulds Pumps, Inc., Seneca Falls, N. Y.
● Ingersoll-Rand, New York, N. Y.
Kimball Krogh Pump Co., Los Angeles, Cal.
Kraisel Co., Inc., Hackensack, N. J.
Lawrence Pump & Engine Co., Lawrence, Mass.
Lecourtenay Co., Newark, N. J.
Lewis & Co., Chas. S., St. Louis, Mo.
Morris Machine Works, Baldwinsville, N. Y.
● Nash Engineering Co., South Norwalk, Conn.
Palmer Electric Co., Detroit, Mich.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Quimby Pump Co., Inc., Newark, N. J.
Roots-Connersville Blower Corp., Connersville, Ind.
Roper Corp., Geo. D., Rockford, Ill.
Rumsey Pump Co., Ltd., Seneca Falls, N. Y.
Swaby Mfg. Co., Chicago, Ill.
Taber Pump Co., Buffalo, N. Y.
Trane Co., La Crosse, Wis.
Trimount Rotary Power Co., East Dedham, Mass.
Union Steam Pump Co., Battle Creek, Mich.
Viking Pump Co., Cedar Falls, Ia.
Weinman Pump Mfg. Co., Columbus, O.
Westco Pump Corp., Davenport, Ia.
Worthington Pump & Machinery Corp., Harrison, N. J.
Yale & Towne Mfg. Co., Stamford, Conn.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, VACUUM

● Allis-Chalmers Mfg. Co., Milwaukee, Wis.
● American Steam Pump Co., Battle Creek, Mich.
● Ames Pump Co., Inc., New York, N. Y.
Buffalo Pumps, Inc., Buffalo, N. Y.
Dunham Co., C. A., Chicago, Ill.
Economy Pumping Mchry. Co., Chicago, Ill.
● Hoffman Specialty Co., Waterbury, Conn.
● Ingersoll-Rand, New York, N. Y.
● Nash Engineering Co., South Norwalk, Conn.
Skidmore Corp., St. Joseph, Mich.
Worthington Pump & Machinery Corp., New York, N. Y.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, WATER CIRCULATING

● Allis-Chalmers Mfg. Co., Milwaukee, Wis.
● American Steam Pump Co., Battle Creek, Mich.
● Ames Pump Co., Inc., New York, N. Y.
Aldrich Pump Co., Allentown, Pa.
Buffalo Pumps, Inc., Buffalo, N. Y.
Chicago Pump Co., Chicago, Ill.
Davidson Co., M. T., New York, N. Y.
Dayton-Dowd Co., Quincy, Ill.
Decatur Pump Co., Decatur, Ill.
De Laval Steam Turbine Co., Trenton, N. J.
Deming Co., Salem O.
Economy Pumping Mchry. Co., Chicago, Ill.
Fairbanks, Morse & Co., Chicago, Ill.
Foster Pump Works, Inc., Brooklyn, N. Y.
Foster Wheeler Corp., New York, N. Y.
Frederick Iron and Steel Co., Frederick, Md.
Goulds Pumps, Inc., Seneca Falls, N. Y.
● Ingersoll-Rand, New York, N. Y.
Kimball Krogh Pump Co., Los Angeles, Cal.
Kraisel Co., Inc., Hackensack, N. J.
Lawrence Pump & Engine Co., Lawrence, Mass.
Lecourtenay Co., Newark, N. J.
Lewis & Co., Chas. S., St. Louis, Mo.
Meier Electric and Machine Co., Indianapolis, Ind.
Morris Machine Works, Baldwinsville, N. Y.
● Nash Engineering Co., South Norwalk, Conn.
Oberdorfer, M. L., Syracuse, N. Y.
Palmer Electric Co., Detroit, Mich.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Pomona Pump Co., Pomona, Cal.

Quimby Pump Co., Inc., Newark, N. J.
Roots-Connersville Blower Corp., Connersville, Ind.
Roper Corp., Geo. D., Rockford, Ill.
Rumsey Pump Co., Ltd., Seneca Falls, N. Y.
Schwitzer-Cummins Co., Indianapolis, Ind.
Sundstrand Machine Tool Co., Rockford, Ill.
Swaby Mfg. Co., Chicago, Ill.
Taber Pump Co., Buffalo, N. Y.
Trane Co., La Crosse, Wis.
Trimount Rotary Power Co., East Dedham, Mass.
Union Steam Pump Co., Battle Creek, Mich.
Viking Pump Co., Cedar Falls, Ia.
Warren Steam Pump Co., Warren, Mass.
Weil Pump Co., Chicago, Ill.
Weinman Pump Mfg. Co., Columbus, O.
Westco Pump Corp., Davenport, Ia.
Worthington Pump & Machinery Corp., Harrison, N. J.
Yale & Towne Mfg. Co., Stamford, Conn.
Yeomans Bros. Co., Chicago, Ill.

RECEIVERS, REFRIGERATING

Alco Products, Inc., New York, N. Y.
American Engineering Co., Philadelphia, Pa.
● Baker Ice Machine Co., Inc., Omaha, Neb.
● Carbondale Machine Corp., Harrison, N. J.
De La Vergne Engine Co., Philadelphia, Pa.
Howe Ice Machine Co., Chicago, Ill.
● Kelvinator Corp., Detroit, Mich.
McCord Radiator & Mfg. Co., Detroit, Mich.
Philadelphia Pipe Bending Co., Philadelphia, Pa.
Reliance Refrigerating Machine Co., Chicago, Ill.
Rome-Turney Radiator Co., Rome, N. Y.
Strang Air Conditioning Corp., Kansas City, Mo.
Triumph Ice Machine Co., Cincinnati, O.
Vogt Machine Co., Henry, Louisville, Ky.
X L Refrigeration Co., Chicago, Ill.

RECIPROCATING COMPRESSORS

See Compressors, Refrigerating, Reciprocating

RECORDERS, COMBINED TEMPERATURE AND HUMIDITY

● Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Foxboro Co., Foxboro, Mass.
● Friez & Sons, Inc., Julien P., Baltimore, Md.
H-B Instrument Co., Philadelphia,, Pa.
Leeds & Northrup Co., Philadelphia, Pa.
Mason-Neilan Regulator Co., Boston, Mass.
Parks-Cramer Co., Fitchburg, Mass.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
Taylor Instrument Companies, Rochester, N. Y.

RECORDERS, HUMIDITY

● Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Foxboro Co., Foxboro, Mass.
● Friez & Sons, Inc., Julien P., Baltimore, Md.
H-B Instrument Co., Philadelphia, Pa.
Leeds & Northrup Co., Philadelphia, Pa.
Mason-Neilan Regulator Co., Boston, Mass.
Parks-Cramer Co., Fitchburg, Mass.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
Taylor Instrument Companies, Rochester, N. Y.

RECORDERS, TEMPERATURE

● Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Foxboro Co., Foxboro, Mass.
● Friez & Sons, Inc., Julien P., Baltimore, Md.
H-B Instrument Co., Philadelphia, Pa.
Leeds & Northrup Co., Philadelphia, Pa.
Mason-Neilan Regulator Co., Boston, Mass.
Moto Meter Gauge & Equipment Corp., La Crosse, Wis.
Practical Instrument Co., Chicago, Ill.
Standard Thermometer, Inc., Boston, Mass.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
Taylor Instrument Companies, Rochester, N. Y.
Thwing Instrument Co., Philadelphia, Pa.

REDUCERS, SPEED

● Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Boston Gear Works, Inc., North Quincy, Mass.
Jones Foundry Machine Co., W. A., Chicago, Ill.
Link-Belt Co., Chicago, Ill.
Medart Co., St. Louis, Mo.
Morse Chain Co., Ithaca, N. Y.
Poole Foundry & Machine Co., Baltimore, Md.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

REFRIGERANTS

Ansul Chemical Co., Marinette, Wis. (sulphur dioxide)
Carbide & Carbon Chemicals Corp., New York, N. Y.
Kinetic Chemicals, Inc., Wilmington, Del. (freon)
Liquid Carbonic Corp., Chicago, Ill. (carbon dioxide)
Pure Carbonic, Inc., New York, N. Y. (carbon dioxide)
Roessler & Hasslacher Chemical Co., Inc., Niagara Falls, N. Y. (methyl chloride)
Virginia Smelting Co., West Norfolk, Va. (sulphur dioxide and methyl chloride)

REFRIGERATING COMPRESSORS

See Compressors, Refrigerating

REGISTERS

Auer Register Co., Cleveland, O.
Best Register Co., Milwaukee, Wis.
Diamond Mfg. Co., Wyoming, Pa.
Hart & Cooley Mfg. Co., Chicago, Ill.
● Independent Register & Mfg. Co., Cleveland, O.
Knowles Mushroom Ventilator Co., New York, N. Y.
Register & Grille Mfg. Co., Brooklyn, N. Y.
Rock Island Register Co., Rock Island, Ill.
Symonds Register Co., St. Louis, Mo.
Tuttle & Bailey, Inc., New Britain, Conn.
Uni-Flo Corp., Detroit, Mich.
United States Register Co., Battle Creek, Mich.
WAJ Manufacturing Co., Kansas City, Mo.
Waterloo Register Co., Waterloo, Ia.

REGULATORS, DAMPER

● Automatic Products Co., Milwaukee, Wis.
Automatic Temperature Control Co., Inc., Philadelphia, Pa.
Barber-Colman Co., Rockford, Ill.
Cook Electric Co., Chicago, Ill.
● Detroit Lubricator Co., Detroit, Mich.
Foxboro Co., Foxboro, Mass.
● Friez & Sons, Inc., Julien P., Baltimore, Md.
Fulton Sylphon Co., Knoxville, Tenn.
Illinois Engineering Co., Chicago, Ill.
● Johnson Service Co., Milwaukee, Wis.
● Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
National Regulator Co., Chicago, Ill.
Parker-Kalon Corp., New York ,N. Y.
Pioneer Heat Regulator Corp., Dayton, O.
Powers Regulator Co., Chicago, Ill.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Russell Electric Co., Chicago, Ill.
Sheer Co., H. M., Quincy, Ill.
Swartwout Co., Cleveland, O.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
Wilbin Instrument Corp., New York, N. Y.
Young Ventilating Co., Cleveland, O.

REGULATORS, PRESSURE

Boylston Steam Specialty Co., Chicago, Ill.
● Bristol Co., Waterbury, Conn.
● Crane Co., Chicago, Ill.
Davis Regulator Company, Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Fisher Governor Co., Marshalltown, Ia.
Illinois Engineering Co., Chicago, Ill.
Kieley & Mueller, New York, N. Y.
Lytton Mfg. Corp., Franklin, Va.
Mason-Neilan Regulator Co., Boston, Mass.
McAlear Mfg. Co., Chicago, Ill.
Monmouth Products Co., Cleveland, O.
Mueller Steam Specialty Co., New York, N. Y.
Pittsburgh Equitable Meter Co., Pittsburgh, Pa.
Schutte & Koerting Co., Philadelphia, Pa.
Spence Engineering Co., New York, N. Y.
● Strong, Carlisle & Hammond Co., Cleveland, O.
Swartwout Co., Cleveland, O.

RELAYS

See Controls, Electric Motor

ROLLER BEARINGS
See Bearings, Roller

ROTARY COMPRESSORS
See Compressors, Refrigerating, Rotary

SHEETS, ALLOY
Allegheny Steel Co., Brackenridge, Pa. (Allegheny metal)
Aluminum Co. of America, Pittsburgh, Pa. (Aluminum)
● American Brass Co., Waterbury, Conn.
American Rolling Mill Co., Middletown, O.
Crucible Steel Co. of America, New York, N. Y.
Duriron Co., Inc., Dayton, O. (Acid-proof)
International Nickel Co., New York, N. Y. (Monel metal)
Lukens Steel Co., Coatesville, Pa.
Newport Rolling Mill Co., Newport, Ky.
● Republic Steel Corp., Youngstown, O.
● Revere Copper & Brass, Inc., New York, N. Y.
● Youngstown Sheet and Tube Co., Youngstown, O.

SHEETS, COPPER
● American Brass Co., Waterbury, Conn.
Bridgeport Brass Co., Bridgeport, Conn.
Chase Brass & Copper Co., Waterbury, Conn.
Hussey & Co., C. G., Pittsburgh, Pa.
New Haven Copper Co., Seymour, Conn.
● Revere Copper & Brass, Inc., New York, N. Y.

SHEETS, COPPER BEARING STEEL
American Rolling Mill Co., Middletown, O.
American Sheet and Tin Plate Co., Pittsburgh, Pa.
Apollo Steel Co., Apollo, Pa.
Bethlehem Steel Co., Bethlehem, Pa.
Follansbee Bros. Co., Pittsburgh, Pa.
Granite City Steel Co., Granite City, Ill.
Inland Steel Co., Chicago, Ill.
Lukens Steel Co., Coatesville, Pa.
Newport Rolling Mill Co., Newport, Ky.
● Republic Steel Corp., Youngstown, O.
Superior Sheet Steel Co., Canton, O.
Weirton Steel Co., Weirton, W. Va.
Wheeling Steel Corp., Wheeling, W. Va.
● Youngstown Sheet and Tube Co., Youngstown, O.

SHEETS, GALVANNEALED
American Sheet and Tin Plate Co., Pittsburgh, Pa.
● Republic Steel Corp., Youngstown, O.
Superior Sheet Steel Co., Canton, O.
● Youngstown Sheet and Tube Co., Youngstown, O.

SHEETS, IRON AND STEEL
American Rolling Mill Co., Middletown, O.
American Sheet and Tin Plate Co., Pittsburgh, Pa.
Apollo Steel Co., Apollo, Pa.
Bethlehem Steel Co., Bethlehem, Pa.
● Byers, A. M., Pittsburgh, Pa. (Genuine wrought iron)
Continental Steel Corp., Kokomo, Ind.
Follansbee Bros. Co., Pittsburgh, Pa.
Granite City Steel Co., Granite City, Ill.
Gulf States Steel Co., Birmingham, Ala.
Inland Steel Co., Chicago, Ill.
Lukens Steel Co., Coatesville, Pa.
Newport Rolling Mill Co., Newport, Ky.
Otis Steel Co., Cleveland, O.
● Reading Iron Co., Philadelphia, Pa. (Genuine wrought iron)
● Republic Steel Corp., Youngstown, O.
Superior Sheet Steel Co., Canton, O.
Weirton Steel Co., Weirton, W. Va.
Wheeling Steel Corp., Wheeling, W. Va.
● Youngstown Sheet and Tube Co., Youngstown, O.

SHEETS, STAINLESS STEEL
Allegheny Steel Co., Brackenridge, Pa.
American Rolling Mill Co., Middletown, O.
American Sheet and Tin Plate Co., Pittsburgh, Pa.
Crucible Steel Co. of America, New York, N. Y.
Ingersoll Steel & Disc Co., Chicago, Ill. (Two ply)
Ludlum Steel Co., Watervliet, N. Y.
● Republic Steel Corp., Youngstown, O.

SILICA GEL
See Adsorbents

SOLENOID VALVES
See Valves, Solenoid

SOUND INSULATION
See Insulation, Sound

SPEED REDUCERS
See Reducers, Speed

SPRAY NOZZLES
See Nozzles, Spray, Air Washer and Cooling Tower

STEAM EJECTORS
See Compressors, Refrigerating, Steam Jet

STEAM ENGINES
See Engines, Steam

STEAM JET REFRIGERATION
See Compressors, Refrigerating, Steam Jet

STRAINERS
● American District Steam Co., North Tonawanda, N. Y.
Boylston Steam Specialty Co., Chicago, Ill.
Davis Regulator Co., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
● Detroit Lubricator Co., Detroit, Mich.
Fisher Governor Co., Marshalltown, Ia.
Kieley & Mueller, New York, N. Y.
Mason-Neilan Regulator Co., Boston, Mass.
McAlear Mfg. Co., Chicago, Ill.
Monmouth Products Co., Cleveland, O.
Mueller Steam Specialty Co., New York, N. Y.
Pittsburgh Equitable Meter Co., Pittsburgh, Pa.
● Sarco Co., New York, N. Y.
Spence Engineering Co., New York, N. Y.
● Strong, Carlisle & Hammond Co., Cleveland, O.
Swartwout Co., Cleveland, O.

SURFACE, COOLING, BRINE
● Aerofin Corp., Newark, N. J.
Aluminol Products Corp., Cleveland, O.
American Engineering Co., Philadelphia, Pa.
● Baker Ice Machine Co., Inc., Omaha, Neb.
● Bush Mfg. Co., Hartford, Conn.
● Carbondale Machine Corp., Harrison, N. J.
● Clarage Fan Co., Kalamazoo, Mich.
● Fedders Mfg. Co., Inc., Buffalo, N. Y.
Filtrine Mfg. Co., Inc., Brooklyn, N. Y.
● Frick Co., Waynesboro, Pa.
G. & O. Manufacturing Co., New Haven, Conn.
● General Electric Co., Schenectady, N. Y.
Griscom-Russell Co., New York, N. Y.
Howe Ice Machine Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
King Ventilating Co., Owatonna, Minn.
McCord Radiator & Mfg. Co., Detroit, Mich.
● Modine Mfg. Co., Racine, Wis.
Niagara Blower Co., New York, N. Y.
Philadelphia Pipe Bending Co., Philadelphia, Pa.
Reliance Refrigerating Machine Co., Chicago, Ill.
Rempe Co., Chicago, Ill.
Rome-Turney Radiator Co., Rome, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.
Thermal Units Mfg. Co., Chicago, Ill.
Trane Co., La Crosse, Wis.
Unit Heater & Cooler Co., Wausau, Wis.
● Vilter Mfg. Co., Milwaukee, Wis.
Vogt Machine Co., Henry, Louisville, Ky.
● Wing Mfg. Co., L. J., New York, N. Y.
● Wittenmeier Machinery Co., Chicago, Ill.
X L Refrigerating Co., Chicago, Ill.
York Ice Machinery Co., York, Pa.
Young Radiator Co., Racine, Wis.

SURFACE, COOLING, COLD WATER
● Aerofin Corp., Newark, N. J.
American Engineering Co., Philadelphia, Pa.
American Radiator Co., New York, N. Y.
● Baker Ice Machine Co., Inc., Omaha, Neb.
Bon Air Radiator Corp., Boston, Mass.
● Bush Mfg. Co., Hartford, Conn.
● Carbondale Machine Corp., Harrison, N. J.
● Clarage Fan Co., Kalamazoo, Mich.
● Fedders Mfg. Co., Inc., Buffalo, N. Y.
Filtrine Mfg. Co., Inc., Brooklyn, N. Y.
● Frick Co., Waynesboro, Pa.
G. & O. Mfg. Co., New Haven, Conn.

● General Electric Co., Schenectady, N. Y.
Griscom-Russell Co., New York, N. Y.
Hitchen Engineering Co., Inc., New York, N. Y.
Kauffman Air Conditioning Corp., St. Louis, Mo.
King Ventilating Co., Owatonna, Minn.
McCord Radiator & Mfg. Co., Detroit, Mich.
● Modine Mfg. Co., Racine, Wis.
Nesbitt, Inc., John J., Philadelphia, Pa.
Niagara Blower Co., New York, N. Y.
Philadelphia Pipe Bending Co., Philadelphia, Pa.
Reliance Refrigerating Machine Co., Chicago, Ill.
Rempe Co., Chicago, Ill.
Rome-Turney Radiator Co., Rome, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.
● Sturtevant Co., B. F., Boston, Mass.
Super Radiator Corp., Minneapolis, Minn.
Thermal Units Mfg. Co., Chicago, Ill.
Trane Co., La Crosse, Wis.
Unit Heater & Cooler Co., Wausau, Wis.
U. S. Air Conditioning Corp., Minneapolis, Minn.
Vogt Machine Co., Henry, Louisville, Ky.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
● Wing Mfg. Co., L. J., New York, N. Y.
● Wittenmeier Machinery Co., Chicago, Ill.
York Ice Machinery Co., York, Pa.
Young Radiator Co., Racine, Wis.

SURFACE, COOLING, DIRECT EXPANSION

● Aerofin Corp., Newark, N. J.
Aluminol Products Corp., Cleveland, O.
American Engineering Co., Philadelphia, Pa.
● Baker Ice Machine Co., Inc., Omaha, Neb.
● Bush Mfg. Co., Hartford, Conn.
● Carbondale Machine Corp., Harrison, N. J.
● Fedders Mfg. Co., Inc., Buffalo, N. Y.
● Frick Co., Waynesboro, Pa.
G. & O. Mfg. Co., New Haven, Conn.
● General Electric Co., Schenectady, N. Y.
General Refrigeration Sales Co., Beloit, Wis.
Howe Ice Machine Co., Chicago, Ill.
Ilg Electric Ventilating Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
King Ventilating Co., Owatonna, Minn.
Larkin Refrigerating Corp., Atlanta, Ga.
McCord Radiator & Mfg. Co., Detroit, Mich.
● Modine Mfg. Co., Racine, Wis.
Nesbitt, Inc., John J., Philadelphia, Pa.
Niagara Blower Co., New York, N. Y.
Peerless Ice Machine Co., Chicago, Ill.
Philadelphia Pipe Bending Co., Philadelphia, Pa.
Reliance Refrigerating Machine Co., Chicago, Ill.
Rempe Co., Chicago, Ill.
Rome-Turney Radiator Co., Rome, N. Y.
● Sturtevant Co., B. F., Boston, Mass.
Super Radiator Corp., Minneapolis, Minn.
Thermal Units Mfg. Co., Chicago, Ill.
Trane Co., LaCrosse, Wis.
Trenton Auto Radiator Wks., Trenton, N. J.
Triumph Ice Machine Co., Cincinnati, O.
Unit Heater & Cooler Co., Wausau, Wis.
U. S. Air Conditioning Corp., Minneapolis, Minn.
● Vilter Mfg. Co., Milwaukee, Wis.
Vogt Machine Co., Henry, Louisville, Ky.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
● Wittenmeier Machinery Co., Chicago, Ill.
X L Refrigerating Co., Chicago, Ill.
Yates-American Machine Co., Beloit, Wis.
Young Radiator Co., Racine, Wis.

SURFACE, HEATING, FERROUS

American Radiator Co., New York, N. Y.
Bayley Blower Co., Milwaukee, Wis.
● Buffalo Forge Co., Buffalo, N. Y.
● Burnham Boiler Co., Irvington, N. Y.
● Carbondale Machine Corp., Harrison, N. J.
Griscom-Russell Co., New York, N. Y.
McCord Radiator & Mfg. Co., Detroit, Mich.
Philadelphia Pipe Bending Co., Philadelphia, Pa.
Rempe Co., Chicago, Ill.
Shaw-Perkins Co., Pittsburgh, Pa.
● Sturtevant Co., B. F., Boston, Mass.
Unit Heater & Cooler Co., Wausau, Wis.
York Ice Machinery Co., York, Pa.

SURFACE, HEATING, NON-FERROUS

● Aerofin Corp., Newark, N. J.
American Radiator Co., New York, N. Y.
Bayley Blower Co., Milwaukee, Wis.
Bon Air Radiator Corp., Boston, Mass.
● Buffalo Forge Co., Buffalo, N. Y.
● Clarage Fan Co., Kalamazoo, Mich.
G. & O. Mfg. Co., New Haven, Conn.
● General Electric Co., Schenectady, N. Y.
Griscom-Russell Co., New York, N. Y.
Hitchen Engineering Co., Inc., New York, N. Y.
McCord Radiator & Mfg. Co., Detroit, Mich.
● Modine Mfg. Co., Racine, Wis.
Nelson Corp., Herman, Moline, Ill.
Nesbitt, Inc., John J., Philadelphia, Pa.
Niagara Blower Co., New York, N. Y.
Philadelphia Pipe Bending Co., Philadelphia, Pa.
Rempe Co., Chicago, Ill.
● Revere Copper & Brass, Inc., New York, N. Y.
Rome-Turney Radiator Co., Rome, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.
● Sturtevant Co., B. F., Boston, Mass.
Super Radiator Corp., Minneapolis, Minn.
Thermal Units Mfg. Co., Chicago, Ill.
Trenton Auto Radiator Wks., Trenton, N. J.
Tuttle & Bailey, Inc., New Britain, Conn.
Unit Heater & Cooler Co., Wausau, Wis.
Warren Webster Co., Camden, N. J.
Winchester Repeating Arms Co., New Haven, Conn.
● Wing Mfg. Co., L. J., New York, N. Y.
Wolverine Tube Co., Detroit, Mich.
York Ice Machinery Co., York, Pa.
Young Radiator Co., Racine, Wis.

SWITCHES

See Controls, Electric Motor

SYSTEMS, AIR CONDITIONING, CENTRAL, COMFORT

(Heating, cooling, humidifying, dehumidifying, cleaning and circulating)

Airtemp, Inc., New York, N. Y.
American Blower Corp., Detroit, Mich.
American Engineering Co., Philadelphia, Pa.
Autovent Fan & Blower Co., Chicago, Ill.
● Baker Ice Machine Co., Inc., Omaha, Neb.
Bayley Blower Co., Milwaukee, Wis.
Bishop & Babcock Sales Co., Cleveland, O.
● Buffalo Forge Co., Buffalo, N. Y.
Builders Iron Foundry, Providence, R. I.
● Carbondale Machine Corp., Harrison, N. J.
Carrier Engineering Corp., Newark, N. J.
● Clarage Fan Co., Kalamazoo, Mich.
● Frick Co., Waynesboro, Pa.
Frigidaire Corp., Dayton, O.
● General Electric Co., Schenectady, N. Y.
Grinnell Co., Inc., Providence, R. I.
Ilg Electric Ventilating Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
● Kelvinator Corp., Detroit, Mich.
King Ventilating Co., Owatonna, Minn.
McCormick Co., J. H., Williamsport, Pa.
Niagara Blower Co., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Reliance Refrigerating Machine Co., Chicago, Ill.
Research Corp., New York, N. Y.
Somers, Inc., H. J., Detroit, Mich.
● Sturtevant Co., B. F., Boston, Mass.
Thermal Units Mfg. Co., Chicago, Ill.
Trane Co., La Crosse, Wis.
Typhoon Air Conditioning Co., New York, N. Y.
U. S. Air Conditioning Corp., Minneapolis, Minn.
● Vilter Mfg. Co., Milwaukee, Wis.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
● Wittenmeier Machinery Co., Chicago, Ill.
York Ice Machinery Co., York, Pa.

SYSTEMS, AIR CONDITIONING, CENTRAL, INDUSTRIAL

(Heating, cooling, humidifying, dehumidifying, cleaning and circulating)

American Blower Corp., Detroit, Mich.
American Engineering Co., Philadelphia, Pa.
Autovent Fan & Blower Co., Chicago, Ill.
● Baker Ice Machine Co., Inc., Omaha, Neb.
Bayley Blower Co., Milwaukee, Wis.
Bishop & Babcock Sales Co., Cleveland, O.
● Buffalo Forge Co., Buffalo, N. Y.
● Carbondale Machine Corp., Harrison, N. J.
Carrier Engineering Corp., Newark, N. J.
● Clarage Fan Co., Kalamazoo, Mich.
Columbus Humidifier Co., Columbus, O.
Drying Systems, Inc., Chicago, Ill.
Economy Equipment Co., Chicago, Ill.
● Frick Co., Waynesboro, Pa.
Frigidaire Corp., Dayton, O.
● General Electric Co., Schenectady, N. Y.
Hydrozone Co., Inc., New York, N. Y.
Ilg Electric Ventilating Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
● Kelvinator Corp., Detroit, Mich.
King Ventilating Co., Owatonna, Minn.
Niagara Blower Co., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Reliance Refrigerating Machine Co., Chicago, Ill.
Research Corp., New York, N. Y.
Somers, Inc., H. J., Detroit, Mich.
● Sturtevant Co., B. F., Boston, Mass.
Thermal Units Mfg. Co., Chicago, Ill.
Trane Co., La Crosse, Wis.
U. S. Air Conditioning Corp., Minneapolis, Minn.
● Vilter Mfg. Co., Milwaukee, Wis.
● Wittenmeier Machinery Co., Chicago, Ill.
York Ice Machinery Co., York, Pa.

SYSTEMS, HUMIDIFYING, DIRECT

Bahnson Co., Winston-Salem, N. C.
● Binks Manufacturing Co., Chicago, Ill.
Grinnell Co., Inc., Providence, R. I.
International Moistening Co., Providence, R. I.
Jackson Moistening Co., Fall River, Mass.
Parks-Cramer Co., Fitchburg, Mass. (Also, combination of forced ventilation with direct humidifying system under control of automatic humidity and air change regulator)
Rhode Island Humidifier & Ventilating Co., Boston, Mass.
Southworth Machine Co., Portland, Me.
Spray Engineering Co., Somerville, Mass.
Standard Engineering Wks., Pawtucket, R. I.
Strang Air Conditioning Corp., Kansas City, Mo.

SYSTEMS, HUMIDIFYING, INDIRECT

American Blower Corp., Detroit, Mich.
Bahnson Co., Winston-Salem, N. C.
Bayley Blower Co., Milwaukee, Wis.
● Binks Mfg. Co., Chicago, Ill.
Bishop & Babcock Sales Co, Cleveland, O.
Blom-Gamarra Humidifier, New York, N. Y.
● Buffalo Forge Co., Buffalo, N. Y.
Campbell Companies, E. K., Kansas City, Mo.
● Carbondale Machine Corp., Harrison, N. J.
Carrier Engineering Corp., Newark, N. J.
● Clarage Fan Co., Kalamazoo, Mich.
Columbus Humidifier Co., Columbus, O.
Fitz Gibbon & Crisp, Inc., Trenton, N. J.
Industrial Dryer Corp., Stamford, Conn.
● Johnson Service Co., Milwaukee, Wis.
King Ventilating Co., Owatonna, Minn.
Kleenaire Corp., Stevens Point, Wis.
Parks-Cramer Co., Fitchburg, Mass.
Research Corp., New York, N. Y.
Savage Arms Corp., New York, N. Y.
Somers, Inc., H. J., Detroit, Mich.
● Sturtevant Co., B. F., Boston, Mass.
U. S. Air Conditioning Corp., Minneapolis, Minn.
● Wing Mfg. Co., L. J., New York, N. Y.

TEMPERATURE CONTROLS

See Controls, Room Temperature

TEMPERATURE RECORDERS

See Recorders, Temperature

THERMO-COMPRESSORS

See Compressors, Refrigerating, Steam Jet

THERMOMETERS, INDICATING

● Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
Dusinberre Indicator Co., Kew Gardens, N. Y.
Fee and Stemwedel, Inc., Chicago, Ill.
Foxboro Co., Foxboro, Mass.
● Friez & Sons, Inc., Julien P., Baltimore, Md.
H-B Instrument Co., Philadelphia, Pa.
● Johnson Service Co., Milwaukee, Wis.
Johnson Tool Co., East Providence, R. I.
Leeds & Northrup Co., Philadelphia, Pa.
Mason-Neilan Regulator Co., Boston, Mass.
● Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Moto Meter Gauge & Equipment Corp., La Crosse, Wis.
Palmer Co., Cincinnati, O.
Philadelphia Thermometer Co., Philadelphia, Pa.
Powers Regulator Co., Chicago, Ill.
Scientific Instrument Co., Detroit, Mich.
Standard Thermometer, Inc., Boston, Mass.
Tagliabue Mfg. Co., C. J., Brooklyn, N. Y.
Taylor Instrument Companies, Rochester, N. Y.
Thwing Instrument Co., Philadelphia, Pa.
United States Gauge Co., New York, N. Y.
Wilbin Instrument Corp., New York, N. Y.

THERMOSTATS, DUCT

Barber-Colman Co., Rockford, Ill.
Bishop & Babcock Sales Co., Cleveland, O.
● Bristol Co., Waterbury, Conn.
Cook Electric Co., Chicago, Ill.
● Detroit Lubricator Co., Detroit, Mich.
● Friez & Sons, Inc., Julien P., Baltimore, Md.
Fulton Sylphon Co., Knoxville, Tenn.
● Johnson Service Co., Milwaukee, Wis.
● Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Monmouth Products Co., Cleveland, O. (Hydraulic).
National Regulator Co., Chicago, Ill.
Penn Electric Switch Co., Des Moines, Ia.
Powers Regulator Co., Chicago, Ill.
Russell Electric Co., Chicago, Ill.
● Sarco Co., New York, N. Y.
Wilbin Instrument Corp., New York, N. Y.

TOWERS, COOLING, ATMOSPHERIC

● Baker Ice Machine Co., Inc., Omaha, Neb.
● Binks Mfg. Co., Chicago, Ill.
Burhorn Co., Edwin, Hoboken, N. J.
Cooling Tower Co., Inc., New York, N. Y.
Fluor Corp., Los Angeles, Cal.
Foster Wheeler Corp., New York, N. Y.
Marley Co., Kansas City, Mo.
Penn Spray Tower Wks., Pittsburgh, Pa.
Pennsylvania Engineering Wks., New Castle, Pa.
● Schubert-Christy Corp., St. Louis, Mo.
Tippett & Wood, Phillipsburg, N. J.
Water Cooling Tower Co., Chicago, Ill.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

TOWERS, COOLING, MECHANICAL DRAFT

● Baker Ice Machine Co., Omaha, Neb.
● Binks Mfg. Co., Chicago, Ill.
Burhorn Co., Edwin, Hoboken, N. J.
Cooling Tower Co., Inc., New York, N. Y.
Foster Wheeler Corp., New York, N. Y.
Marley Co., Kansas City, Mo.
Penn Spray Tower Wks., Pittsburgh, Pa.
Pennsylvania Engineering Wks., New Castle, Pa.
Research Corp., New York, N. Y.
● Schubert-Christy Corp., St. Louis, Mo.
Water Cooling Tower Co., Chicago, Ill.
Strang Air Conditioning Corp., Kansas City, Mo.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

TRAPS, STEAM

● American District Steam Co., North Tonawanda, N. Y.
Anderson Co., V. D., Cleveland, O.
● Armstrong Machine Wks., Three Rivers, Mich.
Barnes & Jones, Boston, Mass.
Boylston Steam Specialty Co., Chicago, Ill.
Bundy Steam Trap Co., Nashua, N. H.
● Crane Co., Chicago, Ill.
Davis Regulator Co., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Dunham Co., C. A., Chicago, Ill.
Fisher Governor Co., Marshalltown, Ia.
● Hoffman Specialty Co., Inc., Waterbury, Conn.
Illinois Engineering Co., Chicago, Ill.
Kaye & McDonald, West Orange, N. J.
Kieley & Mueller, New York, N. Y.
Klipfel Mfg. Co., Chicago, Ill.
Lytton Mfg. Corp., Franklin, Va.
Marsh Corp., Jas. P., Chicago, Ill.
McAlear Mfg. Co., Chicago, Ill.
Milwaukee Valve Co., Milwaukee, Wis.
Mueller Steam Specialty Co., New York, N. Y.
Nason Mfg. Co., New York, N. Y.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Powers Regulator Co., Chicago, Ill.
● Sarco Co., New York, N. Y.
Spence Engineering Co., New York, N. Y.
● Strong, Carlisle & Hammond Co., Cleveland, O.
Swartwout Co., Cleveland, O.
Webster & Co., Warren, Camden, N. J.
Wright-Austin Co., Detroit, Mich.

TUBING, COPPER

● American Brass Co., Waterbury, Conn.
American Tube Wks., New York, N. Y.
Baltimore Tube Co., Baltimore, Md.
Bridgeport Brass Co., Bridegport, Conn.
Chase Brass & Copper Co., Waterbury, Conn.
● Mueller Brass Co., Port Huron, Mich.
Northern Indiana Brass Co., Elkhart, Ind.
● Revere Copper & Brass, Inc., New York, N. Y.
Scovill Mfg. Co., Waterbury, Conn.
● Streamline Pipe & Fittings Co., Port Huron, Mich.
Wolverine Tube Co., Detroit, Mich.

TURBINES, MECHANICAL DRIVE

● Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Carling Blower Co., Worcester, Mass.
Coppus Engineering Corp., Worcester, Mass.
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
● General Electric Co., Schenectady, N. Y.
Murray Iron Wks., Burlington, Ia.
● Sturtevant Co., B. F., Hyde Park, Boston, Mass.
Terry Steam Turbine Co., Hartford, Conn.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
● Wing Mfg. Co., L. J., New York, N. Y.
Worthington Pump & Machinery Corp., Harrison, N. J.

UNIT AIR CONDITIONERS, COMFORT, SUMMER

Airtemp, Inc., New York, N. Y.
American Engineering Co., Philadelphia, Pa.
● Buffalo Forge Co., Buffalo, N. Y.
Builders Iron Foundry, Providence, R. I.
Carrier Engineering Corp., Newark, N. J.
Chicago Pump Co., Chicago, Ill.
● Clarage Fan Co., Kalamazoo, Mich.
● Frick Co., Waynesboro, Pa.
Frigidaire Corp., Dayton, O.
● General Electric Co., Schenectady, N. Y.
General Refrigeration Sales Co., Beloit, Wis.
Grinnell Co., Inc., Providence, R. I.
Howe Ice Machine Co., Chicago, Ill.
Ilg Electric Ventilating Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
● Kelvinator Corp., Detroit, Mich.
King Ventilating Co., Owatonna, Minn.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
McCord Radiator & Mfg. Co., Detroit, Mich.
● Modine Mfg. Co., Racine, Wis.
Murray Iron Works, Burlington, Ia.
Nesbitt, Inc., John J., Philadelphia, Pa.
Niagara Blower Co., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Peerless Ice Machine Co., Chicago, Ill.
Rempe Co., Chicago, Ill.
Rome-Turney Radiator Co., Rome, N. Y.
Savage Arms Corp., New York, N. Y.
Servel, Inc., Evansville, Ind.
Standard Air Conditioning, Inc., New York, N. Y.
Strang Air Conditioning Corp., Kansas City, Mo.
● Sturtevant Co., B. F., Boston, Mass.
Thermal Units Mfg. Co., Chicago, Ill.
Trane Co., La Crosse, Wis.
Unified Air Conditioning Co., Duluth, Minn.
Unit Heater & Cooler Co., Wausau, Wis.
U. S. Air Conditioning Corp., Minneapolis, Minn.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
X L Refrigerating Co., Chicago, Ill.
York Ice Machinery Co., York, Pa.
Young Radiator Co., Racine, Wis.

UNIT AIR CONDITIONERS, COMFORT, WINTER

Airtemp, Inc., New York, N. Y.
● Buffalo Forge Co., Buffalo, N. Y.
Carrier Engineering Corp., Newark, N. J.
● Clarage Fan Co., Kalamazoo, Mich.
● General Electric Co., Schenectady, N. Y.
Grinnell Co., Inc., Providence, R. I.
Ilg Electric Ventilating Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
King Ventilating Co., Owatonna, Minn.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
● Modine Mfg. Co., Racine, Wis.
Nesbitt, Inc., John J., Philadelphia, Pa.
Niagara Blower Co., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Russell Electric Co., Chicago, Ill.
Savage Arms Corp., New York, N. Y.
Somers, Inc., H. J., Detroit, Mich.
Standard Air Conditioning, Inc., New York, N. Y.
Strang Air Conditioning Corp., Kansas City, Mo.
● Sturtevant Co., B. F., Boston, Mass.
Thermal Units Mfg. Co., Chicago, Ill.
Unified Air Conditioning Co., Duluth, Minn.
U. S. Air Conditioning Corp., Minneapolis, Minn.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
York Ice Machinery Co., York, Pa.
Young Radiator Co., Racine, Wis.

UNIT AIR CONDITIONERS, COMFORT, YEAR-AROUND

Airtemp, Inc., New York, N. Y.
● Buffalo Forge Co., Buffalo, N. Y.
Builders Iron Foundry, Providence, R. I.
Carrier Engineering Corp., Newark, N. J.
● Clarage Fan Co., Kalamazoo, Mich.
De La Vergne Engine Co., Philadelphia, Pa.
Fairbanks, Morse & Co., Chicago, Ill.
Fitz Gibbon & Crisp, Inc., Trenton, N. J.
● Frick Co., Waynesboro, Pa.
Frigidaire Corp., Dayton, O.
● General Electric Co., Schenectady, N. Y.
Grinnell Co., Inc., Providence, R. I.
Ilg Electric Ventilating Co., Chicago, Ill.
Kauffman Air Conditioning Corp., St. Louis, Mo.
● Kelvinator Corp., Detroit, Mich.
King Ventilating Co., Owatonna, Minn.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
McCormick Co., J. H., Williamsport, Pa.
● Modine Mfg. Co., Racine, Wis.
Nesbitt, Inc., John J., Philadelphia, Pa.
Niagara Blower Co., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Savage Arms Corp., New York, N. Y.
Standard Air Conditioning, Inc., New York, N. Y.
● Sturtevant Co., B. F., Boston, Mass.
Thermal Units Mfg. Co., Chicago, Ill.

Trane Co., La Crosse, Wis.
Unified Air Conditioning Co., Duluth, Minn.
U. S. Air Conditioning Corp., Minneapolis, Minn.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
York Ice Machinery Co., York, Pa.
Young Radiator Co., Racine, Wis.

UNIT AIR CONDITIONERS, INDUSTRIAL, COMPLETE

Airtemp, Inc., New York, N. Y.
● Buffalo Forge Co., Buffalo, N. Y.
Carrier Engineering Corp., Newark, N. J.
● Clarage Fan Co., Kalamazoo, Mich.
Fairbanks, Morse & Co., Chicago, Ill.
● Frick Co., Waynesboro, Pa.
Frigidaire Corp., Dayton, O.
Grinnell Co., Inc., Providence, R. I.
Kauffman Air Conditioning Corp., St. Louis, Mo.
● Kelvinator Corp., Detroit, Mich.
King Ventilating Co., Owatonna, Minn.
Lewis Air Conditioners, Inc., Minneapolis, Minn.
McCormick Co., J. H., Williamsport, Pa.
● Modine Mfg. Co., Racine, Wis.
Nesbitt, Inc., John J., Philadelphia, Pa.
Niagara Blower Co., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Research Corp., New York, N. Y.
Savage Arms Corp., New York, N. Y.
● Sturtevant Co., B. F., Boston, Mass.
Thermal Units Mfg. Co., Chicago, Ill.
Unified Air Conditioning Co., Duluth, Minn.
● Vilter Mfg. Co., Milwaukee, Wis.
X L Refrigerating Co., Chicago, Ill.
York Ice Machinery Co., York, Pa.

UNIT AIR CONDITIONERS, INDUSTRIAL, COOLING AND DEHUMIDIFYING

Airtemp, Inc., New York, N. Y.
American Engineering Co., Philadelphia, Pa.
● Buffalo Forge Co., Buffalo, N. Y.
Builders Iron Foundry, Providence, R. I.
Carrier Engineering Corp., Newark, N. J.
● Clarage Fan Co., Kalamazoo, Mich.
● Fedders Mfg. Co., Inc., Buffalo, N. Y.
● Frick Co., Waynesboro, Pa.
Frigidaire Corp., Dayton, O.
General Refrigeration Sales Co., Beloit, Wis.
Grinnell Co., Inc., Providence, R. I.
Howe Ice Machine Co., Chicago, Ill.
Humidi-Cooler Corp., West Haven, Conn.
Kauffman Air Conditioning Corp., St. Louis, Mo.
● Kelvinator Corp., Detroit, Mich.
King Ventilating Co., Owatonna, Minn.
McCord Radiator & Mfg. Co., Detroit, Mich.
● Modine Mfg. Co., Racine, Wis.
Murray Iron Works, Burlington, Ia.
Nesbitt, Inc., John J., Philadelphia, Pa.
Niagara Blower Co., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Rome-Turney Radiator Co., Rome, N. Y.
Silica Gel Corp., Baltimore, Md.
Strang Air Conditioning Corp., Kansas City, Mo.
● Sturtevant Co., B. F., Boston, Mass.
Thermal Units Mfg. Co., Chicago, Ill.
Trane Co., La Crosse, Wis.
Unified Air Conditioning Co., Duluth, Minn.
Unit Heater & Cooler Co., Wausau, Wis.
● Vilter Mfg. Co., Milwaukee, Wis.
● Wing Mfg. Co., L. J., New York, N. Y.
X L Refrigerating Co., Chicago, Ill.
York Ice Machinery Co., York, Pa.

UNIT AIR CONDITIONERS, INDUSTRIAL, HEATING AND HUMIDIFYING

Airtemp, Inc., New York, N. Y.
Bahnson Co., Winston-Salem, N. C.
● Buffalo Forge Co., Buffalo, N. Y.
Carrier Engineering Corp., Newark, N. J.
● Clarage Fan Co., Kalamazoo, Mich.
Fitz Gibbon & Crisp, Inc., Trenton, N. J.
Grinnell Co., Inc., Providence, R. I.
Kauffman Air Conditioning Corp., St. Louis, Mo.
King Ventilating Co., Owatonna, Minn.
● Modine Mfg. Co., Racine, Wis.
Nesbitt, Inc., John J., Philadelphia, Pa.
Niagara Blower Co., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Savage Arms Corp., New York, N. Y.
Somers, Inc., H. J., Detroit, Mich.
● Sturtevant Co., B. F., Boston, Mass.
Thermal Units Mfg. Co., Chicago, Ill.
Unified Air Conditioning Co., Duluth, Minn.
Unit Heater & Cooler Co., Wausau, Wis.
● Wing Mfg. Co., L. J., New York, N. Y.
X L Refrigerating Co., Chicago, Ill.
York Ice Machinery Co., York, Pa.

UNITS, WINDOW VENTILATOR AND FILTER

● American Air Filter Co., Inc., Louisville, Ky.
Burgess Battery Co., Madison, Wis.
Burrowes Corp., Portland, Me.
Coppus Engineering Corp., Worcester, Mass.
Davies Air Filter Co., New York, N. Y.
De Bothezat Corp., New York, N. Y.
Kaiser Co., H. S., Chicago, Ill.
Somers, Inc., H. J., Detroit, Mich.
Standard Air Conditioning, Inc., New York, N. Y.
● Staynew Filter Corp., Rochester, N. Y.
Truscon Steel Co., Youngstown, O.

VACUUM REFRIGERATION

See Compressors, Refrigerating, Centrifugal and Compressors, Refrigerating, Steam Jet

VALVES, BRASS

Belfield & Co., H., Philadelphia, Pa.
Belknap Mfg. Co., Bridgeport, Conn.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
● Crane Co., Chicago, Ill.
● Fairbanks Co., New York, N. Y.
● Hays Mfg. Co., Erie Pa.
● Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Kerotest Mfg. Co., Pittsburgh, Pa.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Valve & Fittings Co., Barberton, O.
Powell Co., Wm., Cincinnati, O.
Reading-Pratt & Cady Co., Bridgeport, Conn.
Schutte & Koerting Co., Philadelphia, Pa.
Scott Valve Mfg. Co., Detroit, Mich.
● Walworth Co., New York, N. Y.

VALVES, DIAPHRAGM

● Bristol Co., Waterbury, Conn.
Fisher Governor Co., Mashalltown, Ia.
● Johnson Service Co., Milwaukee, Wis.
Parks-Cramer Co., Fitchburg, Mass.
Powers Regulator Co., Chicago, Ill.

VALVES, EXPANSION, REFRIGERATING

● Alco Valve Co., Maplewood, St. Louis, Mo.
● Automatic Products Co., Milwaukee, Wis.
● Baker Ice Machine Co., Inc., Omaha, Neb.
● Carbondale Machine Corp., Harrison, N. J.
De La Vergne Engine Co., Philadelphia, Pa.
● Detroit Lubricator Co., Detroit, Mich.
● Fedders Mfg. Co., Inc., Buffalo, N. Y.
● Frick Co., Waynesboro, Pa.
Frigidaire Corp., Dayton, O.
General Refrigeration Sales Co., Beloit, Wis.
● Kelvinator Corp., Detroit, Mich.
● Vilter Mfg. Co., Milwaukee, Wis.
Vogt Machine Co., Henry, Louisville, Ky.
X L Refrigerating Co., Chicago, Ill.

VALVES, IRON BODY

● Crane Co., Chicago, Ill.
Edward Valve & Mfg. Co., East Chicago, Ind.
● Fairbanks Co., New York, N. Y.
● Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Valve & Fittings Co., Barberton, O.
Powell Co., Wm., Cincinnati, O.

Reading-Pratt & Cady Co., Bridgeport, Conn.
Schutte & Koerting Co., Philadelphia, Pa.
Scott Valve Mfg. Co., Detroit, Mich.
● Walworth Co., New York, N. Y.

VALVES, MOTOR-OPERATED

● Alco Valve Co., Maplewood, St. Louis, Mo.
Automatic Temperature Control Co., Philadelphia, Pa.
Barber-Colman Co., Rockford, Ill.
● Bristol Co., Waterbury, Conn.
Central Heat Appliances, Chicago, Ill.
Darling Valve & Mfg. Co., Williamsport, Pa.
● Fairbanks Co., New York, N. Y.
Fisher Governor Co., Marshalltown, Ia.
● General Electric Co., Schenectady, N. Y.
● Jenkins Bros., New York, N. Y.
● Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
● Walworth Co., New York, N. Y.
Wilbin Instrument Corp., New York, N. Y.

VALVES, SOLENOID

● Alco Valve Co., St. Louis, Mo.
● Automatic Products Co., Milwaukee, Wis.
Automatic Switch Co., New York, N. Y.
Barber-Colman Co., Rockford, Ill.
Brown Instrument Co., Philadelphia, Pa.
● Clark Controller Co., Cleveland, O.
Columbus Humidifier Co., Columbus, O.
Cutler-Hammer, Inc., Milwaukee, Wis.
● Detroit Lubricator Co., Detroit, Mich.
Electric Valve Mfg. Co., Inc., New York, N. Y.
● Frick Co., Waynesboro, Pa.
● Friez & Sons, Inc., Julien P., Baltimore, Md.
● General Electric Co., Schenectady, N. Y.
Keckley Co., O. C., Chicago, Ill.
Merchant & Evans Co., Philadelphia, Pa.
Mercoid Corp., Chicago, Ill.
● Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Monmouth Products Co., Cleveland, O. (Electric)
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Powell Co., Wm., Cincinnati, O.
Powers Regulator Co., Chicago, Ill.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Wilbin Instrument Corp., New York, N. Y.

VALVES, STEEL

● Crane Co., Chicago, Ill.
Homestead Valve Mfg. Co., Coraopolis, Pa.
Lunkenheimer Co., Cincinnati, O.
Powell Co., Wm., Cincinnati, O.
Reading-Pratt & Cady Co., Bridgeport, Conn.
Schutte & Koerting Co., Philadelphia, Pa.
● Walworth Co., New York, N. Y.

VENETIAN BLINDS

Athey Co., Chicago, Ill.
Bostwick-Goodell Co., Norwalk, O.
Chicago Venetian Blind Co., Chicago, Ill.
Columbia Mills, Inc., Saginaw, Mich.
Higgin Mfg. Co., Newport, Ky.
Hough Co., Janesville, Wis.
Kane Mfg. Co., Kane, Pa.
Miller & Connell Co., Chicago, Ill.
Mitchell Moulding Co., Forest Park, Ill.
Patterson Shade Co., Indianapolis, Ind.
Schatz Venetian Blinds, Los Angeles, Cal.
Swedish Venetian Blind Co., New York, N. Y.
Warren Shade Co., Inc., Minneapolis, Minn.
Western Venetian Blind Co., New York, N. Y.
Yardley Screen & Weather Strip Corp., Columbus, O.

VENTILATORS, MUSHROOM

American Blower Corp., Detroit, Mich.
American Foundry & Furnace Co., Bloomington, Ill.
Best Register Co., Milwaukee, Wis.
Knowles Mushroom Ventilator Co., New York, N. Y.
Niagara Blower Co., New York, N. Y.
● Sturtevant Co., B. F., Boston, Mass.
Tuttle & Bailey, Inc., New Britain, Conn.
Ventilating Products Co., Chicago, Ill.

WASHERS, AIR

American Blower Corp., Detroit, Mich.
American Coolair Corp., Jacksonville, Fla.
Bayley Blower Co., Milwaukee, Wis.
Bishop & Babcock Sales Co., Cleveland, O.
● Buffalo Forge Co., Buffalo, N. Y.
Campbell Companies, E. K., Kansas City, Mo.
Carrier Engineering Corp., Newark, N. J.
● Clarage Fan Co., Kalamazoo, Mich.
Kauffman Air Conditioning Corp., St. Louis, Mo.
King Ventilating Co., Owatonna, Minn.
Niagara Blower Co., New York, N. Y.
Parks-Cramer Co., Fitchburg, Mass.
Penn Spray Tower Wks., Pittsburgh, Pa.
Research Corp., New York, N. Y.
Savage Arms Corp., New York, N. Y.
Scott Ballantyne Co., Omaha, Neb.
Spray Engineering Co., Somerville, Mass.
● Sturtevant Co., B. F., Boston, Mass.
Super-Aire Conditioning Corp., St. Louis, Mo.
Trane Co., La Crosse, Wis.
Typhoon Air Conditioning Co., New York, N. Y.
U. S. Air Conditioning Corp., Minneapolis, Minn.

WATER TREATMENT

Ferro-Nil Corp., New York, N. Y.
Haering Co., D. W., Chicago, Ill.
Metropolitan Refining Co., Long Island City, N. Y.
Ozone Pure Airifier Co., Chicago, Ill.

WATER VAPOR REFRIGERATION

See Compressors, Refrigerating, Centrifugal and Compressors, Refrigerating, Steam Jet

WEATHER STRIPS, METAL

All Metal Weatherstrip Co., Chicago, Ill.
Athey Co., Chicago, Ill.
Burrowes Corp., Portland, Me.
Chamberlin Metal Weather Strip Co., Detroit, Mich.
Higgin Mfg. Co., Newport, Ky.
Monarch Metal Weatherstrip Co., St. Louis, Mo.
Northern Weatherstrip Co., Duluth, Minn.
Yardley Screen & Weather Strip Corp., Columbus, O.

WHEELS, FAN AND BLOWER

Airmaster Corp., Chicago, Ill.
American Blower Corp., Detroit, Mich.
American Foundry & Furnace Co., Bloomington, Ill.
Bayley Blower Co., Milwaukee, Wis.
Bishop & Babcock Sales Co., Cleveland, O.
● Buffalo Forge Co., Buffalo, N. Y.
Champion Blower & Forge Co., Lancaster, Pa.
● Clarage Fan Co., Kalamazoo, Mich.
De Bothezat Corp., New York, N. Y.
Dixie Mfg. Co., Inc., Baltimore, Md.
Garden City Fan Co., Chicago, Ill.
Janette Mfg. Co., Chicago, Ill.
Meier Electric & Machine Co., Indianapolis, Ind.
Myers Electric Co., Pittsburgh, Pa.
Niagara Blower Co., New York, N. Y.
Peerless Electric Co., Warren, O.
Russell Electric Co., Chicago, Ill.
Schwitzer-Cummins Co., Indianapolis, Ind.
● Sturtevant Co., B. F., Boston, Mass.
● Torrington Mfg. Co., Torrington, Conn.
U. S. Air Conditioning Corp., Minneapolis, Minn.
● Wing Mfg. Co., L. J., New York, N. Y.

WINDOW VENTILATOR AND FILTER UNITS

See Units, Window Ventilator and Filter

WINTER AIR CONDITIONERS

See Unit Air Conditioners

DIRECTORY

OF INDUSTRIAL AND COMMERCIAL AIR CONDITIONING EQUIPMENT SECTION

SECTION 2—TRADE NAMES

A. B. C.—Ventilators. American Blower Corp., Detroit, Mich.
Aeracool—Fans, wheels. Myers Electric Co., Pittsburgh, Pa.
Aerovalve—Ventilators. Knowles Mushroom Ventilator Co., New York, N. Y.
Aerovent—Fans. Aerovent Fan Co., Piqua, O.
Afco—Ventilating products. American Foundry & Furnace Co, Bloomington, Ill.
Airchanger—Forced ventilation and humidifying systems. Parks-Cramer Co., Fitchburg, Mass.
Airgard—Window ventilator & filter units. American Air Filter Co., Inc., Louisville, Ky.
Airmat—Air filters. American Air Filter Co., Inc., Louisville, Ky.
Airmeter—Hygrometers, indicating thermometers. Johnson Tool Co., East Providence, R. I.
Airozone—Ozone apparatus. Ozone Pure Airifier Co., Chicago, Ill.
Airplex—Air filters. Davies Air Filter Co., New York, N. Y.
Alcumite—Fans. Duriron Co., Inc., Dayton, O.
Allweather—Humidifying systems. Fitz Gibbon & Crisp, Inc., Trenton, N. J.
Amco—Controls. Grinnell Co., Inc., Providence, R. I.
American—Controls and recorders. Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
American-Marsh—Pumps. American Steam Pump Co., Battle Creek, Mich.
Anaconda—Sheets. The American Brass Co., Waterbury, Conn.
Arco—Air filters, pipe. American Radiator Co., New York, N. Y.
Arcoblast—Cooling and heating surface. American Radiator Co., New York, N. Y.
Arctic Nu-Air—Air conditioning systems, diffusers, fans, grilles. U. S. Air Conditioning Corp., Minneapolis, Minn.
Armco—Sheets. American Rolling Mill Co., Middletown, O.
Asco—Valves. Automatic Switch Co., New York, N. Y.
Audiffren—Refrigerating compressors. Builders Iron Foundry, Providence, R. I.

Ballentine—Fans, motors. Russell Electric Co., Chicago, Ill.
Balmi-Aire—Humidifying systems, unit air humidifiers. U. S. Air Conditioning Corp., Minneapolis, Minn.
B.B.—Electric motors. Brown-Brockmeyer Co., Dayton, O.
Blue-Stripe—Insulation. Upson Co., Lockport, N. Y.
Box—Air filters. Burt Air Filter Corp., New York, N. Y.
Breezo—Fans. Buffalo Forge Co., Buffalo, N. Y.

Caloride—Calcium chloride. Research Corp., New York, N. Y.
Calorider—Air conditioning systems, air washers, dehumidifiers, humidifying systems, unit air conditioners. Research Corp., New York, N. Y.
Capitol—Insulation. Standard Lime & Stone Co., Baltimore, Md.
Certified Climate—Air conditioning systems. Parks-Cramer Co., Fitchburg, Mass.
C-H—Motor controls. Cutler-Hammer, Inc., Milwaukee, Wis.
Charavay—Propeller fans. Hartzell Propeller Fan Co., New York, N. Y.
Chill-Vactor—Steam jet water coolers. Croll-Reynolds Co., Inc., New York, N. Y.
Chinook—Ferrous heating surface. Bayley Blower Co., Milwaukee, Wis.
Chinookfin—Non-ferrous heating surface. Bayley Blower Co., Milwaukee, Wis.
Coey—Cooling towers. Research Corp., New York, N. Y.
Comfortrol—Temperature and humidity control. Friez & Sons, Inc., Julien P., Baltimore, Md.
Condor—Flat belt drives, V belt drives. Manhattan Rubber Mfg. Co., Passaic, N. J.
Coppier—Sheets. Superior Sheet Steel Co., Canton, O.
Cop-R-Loy—Sheets. Wheeling Steel Corp., Wheeling, W. Va.
Corinco—Insulation. Cork Insulation Co., Inc., New York, N. Y.

Diamond H—Relays, electrical. Hart Mfg. Co., Hartford, Conn.
Discfin—Cooling surface. General Refrigeration Sales Co., Beloit, Wis.
Disc-Loc—Grilles. Knowles Mushroom Ventilator Co., New York, N. Y.
Double Diamond—Hygrometers. H-B Instrument Co., Philadelphia, Pa.
Double Duty—Air filters. Independent Air Filter Co., Chicago, Ill.
Double-Seal—Copper Tube Fittings. Hays Mfg. Co., Erie, Pa.
Dri-Cool—Dehumidifiers, unit air coolers, unit air humidifiers. U. S. Air Conditioning Corp., Minneapolis, Minn.
Dunco—Motor controls. Struthers Dunn, Inc., Philadelphia, Pa.
Duro-Brace—V belt sheaves. Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Dustop—Air filters. Owens-Illinois Glass Co., Toledo, O.

EC & M—Controls. Electric Controller & Mfg. Co., Cleveland, O.
EKCCO—Air washers, fans, louvers, etc. Campbell Companies, E.K., Kansas City, Mo.
Electrozone—Ozone apparatus. Triox Engineering Co., St. Louis, Mo.
Enduro—Sheets. Republic Steel Corp., Youngstown, O.
Evco—Valves. Electric Valve Mfg. Co., Inc., New York, N. Y.
Everdur—Sheets. American Brass Co., Waterbury, Conn.

Fabrikated—Grilles, registers. Independent Register & Mfg. Co., Cleveland, O.
Fan-O-Plane—Propeller fans. Aircraft Mfg. Co., Dayton, O.
Fanozone—Ozone apparatus. Ozone Pure Airifier Co., Chicago, Ill.
Feltseal—Bearings. Norma-Hoffman Bearings Corp., Stamford, Conn.
Ferrocraft—Grilles. Tuttle & Bailey, Inc., New Britain, Conn.
Ferroflo—Grilles. Tuttle & Bailey, Inc., New Britain, Conn.
Ferrogrid—Registers. Tuttle & Bailey, Inc., New Britain, Conn.
Ferro-Therm—Insulation. American Flange & Mfg. Co., Inc., New York, N. Y.
Flexcord—Drives. Gates Rubber Co., Denver, Col.
Forcedraft—Unit air conditioners. Fedders Mfg. Co., Inc., Buffalo, N. Y.
Freon—Refrigerant. Kinetic Chemicals, Inc., Wilmington, Del.
Fulscope—Controls. Taylor Instrument Companies, Rochester, N. Y.

Gallery—Grilles. Knowles Mushroom Ventilator Co., New York, N. Y.
G-E—Air Conditioning systems and units, controls, motors, etc. General Electric Co., Schenectady, N. Y.
Genuine Detroit—Controls. Detroit Lubricator Co., Detroit, Mich.
Gilt Edge—Leather belts. Rhoads & Sons, J. E., Philadelphia, Pa.
Gimco—Insulation. General Insulating & Mfg. Co., Alexandria, Ind.
Goss Humidimeter—Hygrometers. Humidity Control Co., Tacoma, Wash.
Goss Humistat—Humidity controls. Humidity Control Co., Tacoma, Wash.
G-R—Cooling and heating surface. Griscom-Russell Co., New York, N. Y.
Greaseal—Bearings. Norma-Hoffman Bearings Corp., Stamford, Conn.

H & C—Dampers, grilles, registers. Hart & Cooley Mfg. Co., Chicago, Ill.
Hancock—Steam ejectors. Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.
HB—Pumps. Yeomans Brothers Co., Chicago, Ill.
Herculoy—Silicon bronze. Revere Copper and Brass, Inc., New York, N. Y.
Hi-Spra—Spray nozzles. Schubert-Christy Corp., St. Louis, Mo.
Hitoncast—Grilles. Tuttle & Bailey, Inc., New Britain, Conn.
Hoffman-Economy—Pumps. Hoffman Specialty Co., Inc., Waterbury, Conn.
Hold-Heet—Air conditioning equipment and controls. Russell Electric Co., Chicago, Ill.
Humidiguides—Hygrometers. Taylor Instrument Companies, Rochester, N. Y.
Humiduct—Humidifying systems. Bahnson Co., Winston-Salem, N. C.
Humitherm—Unit air conditioners. Grinnell Co., Inc., Providence, R. I.
Humitrol—Humidity control. Lewis Air Conditioners, Inc., Minneapolis, Minn.
HY-DUTY—Fans. Schwitzer-Cummins Co., Indianapolis, Ind.

Ilgkold—Unit air coolers. Ilg Electric Ventilating Co., Chicago, Ill.

Impact—Nozzles. Cooling Tower Co., Inc., New York, N. Y.
IngAclad—Stainless clad sheets. Ingersoll Steel & Disc Co., Chicago, Ill.
Inso—Insulation. Stewart Inso Board Corp., St. Joseph, Mo.
I-R—Ingersoll-Rand, New York, N. Y.

Jennings—Pumps. Nash Engineering Co., South Norwalk, Conn.
J-M—Insulation. Johns-Manville, New York, N. J.
Jointite—Insulation. Mundet Cork Corp., New York, N. Y.
Juruick—Air conditioning systems. American Engineering Co., Philadelphia, Pa.

Kable Kord—Flat belt drives. L. H. Gilmer Co., Philadelphia, Pa.
K-Fin Bentube—Cooling and heating surface. Hitchen Engineering Co., Inc., New York, N. Y.
Klixon—Controls. Spencer Thermostat Co., Attleboro, Mass.
Kompak—Air filters. Independent Air Filter Co., Chicago, Ill.
Konik—Nickel clad sheets. Superior Sheet Steel Co., Canton, O.
Kooler-Aire—Air washers, dehumidifiers. U. S. Air Conditioning Corp., Minneapolis, Minn.
Kramer—Cooling and heating surface. Trenton Auto Radiator Wks., Trenton, N. J.
Kritzer—Motor bases. Peerless Ice Machine Co., Chicago, Ill.

L. A.—Motors. Louis Allis Co., Milwaukee, Wis.
Lipman — Refrigerating compressors. General Refrigeration Sales Co., Beloit, Wis.

M & E—Refrigerating compressors. Merchant & Evans Co., Philadelphia, Pa.
Magic-Weather—Air washers, fans. Scott Ballantyne Co., Omaha, Neb.
Massachusetts—Air washers, fans and blowers. Bishop & Babcock Sales Co., Cleveland, O.
Master—Controls. Bahnson Co., Winston-Salem, N. C.
Master & Master Jr.—Valves, motor operated. Central Heat Appliances, Chicago, Ill.
Maxine—Venetian blinds. Miller & Connell Co., Chicago, Ill.
McKnight—Registers. Tuttle & Bailey, Inc., New Britain, Conn.
Metaphram—Regulators. National Regulator Co., Chicago, Ill.
Mobilaire—Unit air conditioner. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Modutrol—Control systems. Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Morflex—Couplings. Morse Chain Co., Ithaca, N. Y.
Motoco—Gages, recorders, thermometers. Moto Meter Gauge & Equipment Corp., La Crosse, Wis.
Motopump—Pumps. Yeomans Brothers Co., Chicago, Ill.
Mountainaire—Window ventilator and filter units. Burgess Battery Co., Madison, Wis.
Multifin—Cooling and heating surface. Nesbitt, Inc., John J., Philadelphia, Pa.
Multi-Panel—Air filters. American Air Filter Co., Inc., Louisville, Ky.
Multivane—Fans and blowers. B. F. Sturtevant Co., Boston, Mass.

Newport—Humidity controls. Johnson Tool Co., East Providence, R. I.
Ni-Resist—Pipe. Walworth Co., New York, N. Y.
Non-Frost—Cooling surface. Fedders Mfg. Co., Inc., Buffalo, N. Y.
Northern Breeze—Unit air coolers. Chicago Pump Co., Chicago, Ill.
Novoid—Insulation. Cork Import Corp., New York, N. Y.
Nu-Air—Fans. Meier Electric & Machine Co., Indianapolis, Ind.
Nu-Notch — Mushroom ventilators. Knowles Mushroom Ventilator Co., New York, N. Y.

Oblong—Grilles. Knowles Mushroom Ventilator Co., New York, N. Y.
Ortho-Clime—Unit air conditioners. Fairbanks, Morse & Co., Chicago, Ill.
Ozite—Insulation. American Hair & Felt Co., Chicago, Ill.

Parko—Psychrometers. Parks-Cramer Co., Fitchburg, Mass.
ParkSpray—Humidifying systems. Parks-Cramer Co., Fitchburg, Mass.
Parks Turbo—Humidifying systems. Parks-Cramer Co., Fitchburg, Mass.
Pfening—Industrial air conditioning systems. Columbus Humidifier Co., Columbus, O.
Plexiform—Fans and blowers. Bayley Blower Co., Milwaukee, Wis.
Plumrite—Pipe. Bridgeport Brass Co., Bridgeport, Conn.
Poly-Stage—Air filters. Burt Air Filter Corp., New York, N. Y.
Power—Leather belts. Rhoads & Sons, J. E., Philadelphia, Pa.
Premier—Venetian blinds. Miller & Connell Co., Chicago, Ill.
Protectomotor—Air filters. Staynew Filter Corp., Rochester, N. Y.
Protectovent—Window ventilator and filter units. Staynew Filter Corp., Rochester, N. Y.

R & G—Grilles, registers. Register & Grille Mfg. Co., Brooklyn, N. Y.
Red Top—Humidity and temperature controls. H-B Instrument Co., Philadelphia, Pa.
Relay—Air filters. Humidity Control Co., Tacoma, Wash.
Renu-Vent—Air filters. American Air Filter Co., Inc., Louisville, Ky.
Rexvane—Unit air conditioners. B. F. Sturtevant Co., Boston, Mass.
R-K—Regulators. Ruggles-Klingemann Mfg. Co., Salem, Mass.
Rota-Roll—Pumps. Sundstrand Machine Tool Co., Rockford, Ill.
Rotax — Electric controls. Foxboro Co., Foxboro, Mass.
Rotojet—Spray nozzles. Binks Mfg. Co., Chicago, Ill.

Sanidaire—Humidifying systems. U. S. Air Conditioning Corp., Minneapolis, Minn.
Seal-Clad — Motors. Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Seismo-Dampers—Motor bases. Korfund Co., Long Island City, N. Y.
Silent Floating—Fans. Buffalo Forge Co., Buffalo, N. Y.
Silentvane—Fans and blowers. B. F. Sturtevant Co., Boston, Mass.
Silverlink—Chain drives. Link-Belt Co., Chicago, Ill.
Silverstreak—Chain drives. Link-Belt Co., Chicago, Ill.
Sirocco—Air conditioning systems, air washers, fans and blowers. American Blower Corp., Detroit, Mich.
Speed Heater—Unit air conditioners. B. F. Sturtevant Co., Boston, Mass.
Spirodome—Nozzles. Cooling Tower Co., Inc., New York, N. Y.
Spraco—Air washers. Spray Engineering Co., Somerville, Mass.
Spratower—Cooling towers. Penn Spray Tower Wks., Pittsburgh, Pa.
Streamline—Copper tube fittings and pipe. Streamline Pipe & Fittings Co. (Mueller Brass Co.), Port Huron, Mich.
Streamline—Registers. Tuttle & Bailey, Inc., New Britain, Conn.
Strong—Steam traps. Strong, Carlisle & Hammond Co., Cleveland, O.
Stronghold—Leather belts. Rhoads & Sons, J. E., Philadelphia, Pa.
Sundh—Controls. Clark Controller Co., Cleveland, O.
Superior—Fans and air filters. American Foundry & Furnace Co., Bloomington, Ill.
Surlock—Registers. Tuttle & Bailey, Inc., New Britain, Conn.

T & B—Access doors and panels. Tuttle & Bailey, Inc., New Britain, Conn.
Tag—Controls, instruments. C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
Tannate—Leather belts. Rhoads & Sons, J. E., Philadelphia, Pa.
Teltru—Anemometers, gages. E. Vernon Hill Co., Chicago, Ill.
Temtrol—Controls. Penn Electric Switch Co., Des Moines, Ia.
Texrope—V Belt drives. Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Texsteel—Sheaves, V Belt drives. Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Thermidaire — Humidifying systems. Campbell Companies, E. K., Kansas City, Mo.
Thermolier—Unit air conditioners. Grinnell Co., Inc., Providence, R. I.
Throway—Air filters. American Air Filter Co., Inc., Louisville, Ky.
Timetrol—Controls. Penn Electric Switch Co., Des Moines, Ia.
Toncan—Pipe and sheets. Republic Steel Corp., Youngstown, O.
Trem-Bar—Insulation, fan bases. United States Gypsum Co., Chicago, Ill.
Tri-Sli—Dampers, registers. Tuttle & Bailey, Inc., New Britain, Conn.
Turbo—Air washers, dehumidifiers. Bayley Blower Co., Milwaukee, Wis.
Turbo Vane—Fans and blowers. B. F. Sturtevant Co., Boston, Mass.
Turret—Pumps. Yeomans Brothers Co., Chicago, Ill.
20th Century—Bearings. Roller Bearing Co. of America, Trenton, N. J.
Tymit—Controls. Tork Clock Co., Inc., Mt. Vernon, N. Y.

Uloy—Copper bearing steel sheets. Republic Steel Corp., Youngstown, O.
Uniblade—Fans and blowers. Autovent Fan & Blower Co., Chicago, Ill.
Universal—Air filters. Hugo Mfg. Co., West Duluth, Minn.

Vento—Heating surface. American Radiator Co., New York, N. Y.
Ventura—Fans. American Blower Corp., Detroit, Mich.
Vermiculite—Insulation. International Vermiculite Co., Springfield, Ill.
Victor—Pumps. Kimball Krogh Pump Co., Los Angeles, Cal.
Victoria—Venetian blinds. Bostwick-Goodell Co., Norwalk, O.
Vulcan Sinclair—Hydraulic couplings. American Blower Corp., Detroit, Mich.
Vulco—Drives. Gates Rubber Co., Denver, Col.

Walseal—Bronze fittings. Walworth Co., New York, N. Y.
Weathermaker—Air conditioning systems. Carrier Engineering Corp., Newark, N. J.
Weatherstat — Control. Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

Zephyr Air—Air washers, humidifying systems, unit air conditioners. Savage Arms Corp., New York, N. Y.
Zerozone—Refrigerating compressors. Copeland Refrigeration Corp., Mt. Clemens, Mich.

DIRECTORY

OF INDUSTRIAL AND COMMERCIAL AIR CONDITIONING EQUIPMENT SECTION

SECTION 3—MANUFACTURERS' ADDRESSES

A

Acheson Mfg. Co., Braddock P. O., Rankin, Pa.
● Aerofin Corp., 850 Frelinghuysen Ave., Newark, N. J.
Aerovent Fan Co., Piqua, O.
Aircraft Mfg. Co., 418 E. First St., Dayton, O.
Airmaster Corp., 140 S. Dearborn St., Chicago, Ill.
Airtemp, Inc., Chrysler Bldg., New York, N. Y.
Alco Products, Inc., 220 E. 42nd St., New York, N. Y.
● Alco Valve Co., Inc., 2622 Big Bend Blvd., Maplewood, St. Louis, Mo.
Aldrich Pump Co., 1 Pine St., Allentown, Pa.
Alexander Bros., 406 N. 3rd, Philadelphia, Pa.
Alfol Insulation Co., Inc., Chrysler Bldg., New York, N. Y.
Allegheny Steel Co., Brackenridge, Pa.
Allen Billmyre Corp., 220 E. 42nd St., New York, N. Y.
Allen-Bradley Co., 1326 S. 2nd St., Milwaukee, Wis.
● Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Allis Co., Louis, 427 E. Stewart St., Milwaukee, Wis.
All Metal Weatherstrip Co., 229 W. Illinois St., Chicago, Ill.
Alton Mineral Wool Co., Alton, Ill.
Aluminol Products Corp., 320 Marion Bldg., Cleveland, O.
Aluminum Co. of America, 801 Gulf Bldg., Pittsburgh, Pa.
● American Air Filter Co., Inc., 107 Central Ave., Louisville, Ky.
American Blower Corp., 6000 Russell St., Detroit, Mich.
● American Brass Co., 414 Meadow St., Waterbury, Conn.
American Cast Iron Pipe Co., 2930 N. 16th St., Birmingham, Ala.
American Coolair Corp., Jacksonville, Fla.
● American District Steam Co., North Tonawanda, N. Y.
American Engineering Co., Aramingo & Cumberland St., Philadelphia, Pa.
American Flange & Mfg. Co., Inc., 26 Broadway, New York, N. Y.
American Foundry & Furnace Co., 915 E. Washington St., Bloomington, Ill.
American Hair & Felt Co., 1820 Merchandise Mart, Chicago, Ill.
American Manganese Bronze Co., Rhawn & Hegerman Sts., Philadelphia, Pa.
American Pulley Co., 4200 Wissahickon Ave., Philadelphia, Pa.
American Radiator Co., 40 W. 40th St., New York, N. Y.
American Rolling Mill Co., 703 Curtis St., Middletown, O.
American Sheet and Tin Plate Co., Box 62, Pittsburgh, Pa.
● American Steam Pump Co., Jefferson Ave. & Maple St., Battle Creek, Mich.
American Tube Wks., 501 Fifth Ave., New York, N. Y.
● Ames Pump Co., Inc., 30 Church St., New York, N. Y.
Amthor Testing Instrument Co., 309 Johnson St., Brooklyn, N. Y.
Anderson Co., V. D., 1935 W. 96th St., Cleveland, O.
Ansul Chemical Co., Marinette, Wis.
Apollo Steel Co., Apollo, Pa.
Armstrong Cork Products Co., 993 Concord St., Lancaster, Pa.
● Armstrong Machine Wks., 874 Maple St., Three Rivers, Mich.
Athey Co., 1923 S. Calumet Ave., Chicago, Ill.
Auer Register Co., 3608 Payne Ave., Cleveland, O.
Autoforce Ventilating System, 53 Devonshire St., Boston, Mass.
● Automatic Products Co., 121 N. Broadway, Milwaukee, Wis.
Automatic Switch Co., 154 Grand St., New York, N. Y.
Automatic Temperature Control Co., Inc., 34 E. Logan St., Philadelphia, Pa.
Autovent Fan & Blower Co., 1805 N. Kostner Ave., Chicago, Ill.

B

Babbitt Steam Specialty Co., S. Water, Spring & First Sts., New Bedford, Mass.
Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.
Bahnson Co., Reynolds Bldg., Winston-Salem, N. C.
● Baker Ice Machine Co., Inc., 1590 Evans St., Omaha, Neb.
Baldor Electric Co., 4351-59 Duncan Ave., St. Louis, Mo.
Baltimore Tube Co., 1301 Wicomico St., Baltimore, Md.
Barber-Colman Co., 225 Loomis St., Rockford, Ill.
Barnes & Jones, Inc., 128 Brookside Ave., Jamaica Plain, Boston, Mass.
Bartlett Hayward Co., 200 Scott St., Baltimore, Md.
Bayley Blower Co., 1817 S. 66th St., Milwaukee, Wis.
Belco Exhaust Fan Mfg. Co., 3810 Olive St., St. Louis, Mo.
Belfield & Co., H., 453 N. Broad St., Philadelphia, Pa.
Belknap Mfg. Co., 800 Union Ave., Bridgeport, Conn.
Bender Warrick Corp., 19390 Canterbury, Detroit, Mich.
Bendix Products Corp., 401 Bendix Dr., South Bend, Ind.
Berger Mfg. Co., Canton, O.
Best Register Co., 2005 W. Oklahoma Ave., Milwaukee, Wis.
Bethlehem Steel Co., Bethlehem, Pa.
● Binks Mfg. Co., 3106 Carroll Ave., Chicago, Ill.
Bishop & Babcock Sales Co., 4901 Hamilton Ave., Cleveland, O.
Bliss Co., E. W., 53rd St. & Second Ave., Brooklyn, N. Y.
Blom-Gamarra Humidifier, Rm. 1601, 42 Broadway, New York, N. Y.
Bon Air Radiator Corp., Boston, Mass.
Bonney Forge & Tool Wks., Tilghman St. & Meadow St., Allentown, Pa.
Bossert Corp., 1800 Lenox Ave., Utica, N. Y.
Boston Gear Works, Inc., North Quincy, Mass.
Boston Woven Hose & Rubber Co., Cambridge, Mass.
Bostwick-Goodell Co., Norwalk, O.
Boylston Steam Specialty Co., 116-122 W. Illinois St., Chicago, Ill.
Bridgeport Brass Co., E. Main St., Bridgeport, Conn.
● Bristol Co., Waterbury, Conn.
Brown-Brockmeyer Co., Dayton, O.
Brown Instrument Co., Wayne & Roberts Aves., Philadelphia, Pa.
Brown, Wm. P., 20½ E. Court St., Springfield, Mass.
Brunner Mfg. Co., 1821 Broad St., Utica, N. Y.
● Buffalo Forge Co., 171 Mortimer St., Buffalo, N. Y.
Buffalo Pumps, Inc., 490 Broadway, Buffalo, N. Y.
Builders Iron Foundry, 11 Codding St., Providence, R. I.
Bundy Steam Trap Co., Nashua, N. H.

● Advertisement in this issue. See Index to Advertisers, page 136

Burgess Battery Co., Madison, Wis.
Burhorn Co., Edwin, 1 Newark St., Hoboken, N. J.
● Burnham Boiler Co., Box 74, Irvington, N. Y.
Burrowes Corp., Free St., Portland, Me.
Burt Air Filter Corp., Grand Central Terminal, New York, N. Y.
Burt Mfg. Co., 44 E. South St., Akron, O.
● Bush Mfg. Co., 100 Willington St., Hartford, Conn.
● Byers Co., A. M., Clark Bldg., Pittsburgh, Pa.

C

Cabot, Inc., Samuel, 141 Milk St., Boston, Mass.
Campbell Companies, E. K., 2445 Charlotte St., Kansas City, Mo.
Carbide & Carbon Chemicals Corp., 30 E. 42nd St., New York, N. Y.
● Carbondale Machine Corp., Worthington Ave., Harrison, N. J.
Carey Co., Philip, Lockland, Cincinnati, O.
Carling Blower Co., 104 Harding St., Worcester, Mass.
Carrier Engineering Corp., 850 Frelinghuysen Ave., Newark, N. J.
Celotex Co., 919 N. Michigan Ave., Chicago, Ill.
Central Heat Appliances, 343 S. Dearborn St., Chicago, Ill.
Central Tube Co., First National Bank Bldg., Pittsburgh, Pa.
● Century Electric Co., 1806 Pine St., St. Louis, Mo.
Chace Valve Co., W. M., 1606 Beard Ave., Detroit, Mich.
Chain Belt Co., 1644 W. Bruce, Milwaukee, Wis.
Chamberlin Metal Weather Strip Co., 1254 La Brosse Ave., Detroit, Mich.
Champion Blower & Forge Co., Lancaster, Pa.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Chase Brass & Copper Co., 236 Grand St., Waterbury, Conn.
Chicago Belting Co., 113-125 N. Green St., Chicago, Ill.
Chicago Pump Co., 2336 Wolfram St., Chicago, Ill.
Chicago Venetian Blind Co., 3105 W. 27th St., Chicago, Ill.
Circulair Heat Co., 325 Roland St., Louisville, Ky.
● Clarage Fan Co., Porter St., Kalamazoo, Mich.
● Clark Controller Co., 1146 E. 152nd St., Cleveland, O.
Cohoes Rolling Mill Co., Canvass & Cortland Sts., Cohoes, N. Y.
Columbia Mills, Inc., Saginaw, Mich.
Columbus Heating & Ventilating Co., 400 Dublin Ave., Columbus, O.
Columbus Humidifier Co., 154 N. 5th St., Columbus, O.
Consolidated Air Conditioning Corp., 192 Lexington Ave., New York, N. Y.
Consolidated Ashcroft Hancock Co., Inc., 11 Elias St., Bridgeport, Conn.
Continental Electric Co., Inc., 323 Ferry St., Newark, N. J.
Continental Steel Corp., Kokomo, Ind.
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Cooling Tower Co., Inc., 15 John St., New York, N. Y.
Copeland Refrigeration Corp., 332 Cass Ave., Mt. Clemens, Mich.
Coppus Engineering Corp., 374 Park Ave., Worcester, Mass.
Cork Import Corp., 345-349 W. 40th St., New York, N. Y.
Cork Insulation Co., Inc., 155 E. 44th St., New York, N. Y.
Cornell Wood Products Co., 230 N. Michigan Ave., Chicago, Ill.
● Crane Co., 836 S. Michigan Ave., Chicago, Ill.
Crocker-Wheeler Elec. Mfg. Co., Ampere, N. J.
Croll-Reynolds Co., Inc., 17 John St., New York, N. Y.
Cross Engineering Co., P. O. Drawer 507, Carbondale, Pa.
Crucible Steel Co. of America, 405 Lexington Ave., New York, N. Y.
Cutler-Hammer, Inc., N. 12th St. & W. St. Paul Ave., Milwaukee, Wis.

D

Dallas Engineering Corp., 1115 Hall, Dallas, Tex.
Darling Valve & Mfg. Co., Williamsport, Pa.
● Dart Mfg. Co., E. M., Eddy & Thurber Sts., Providence, R. I.
Davenport Mfg. Co., 301 W. College St., Meadville, Pa.
Davidson Co., M. T., 154 Nassau St., New York, N. Y.
Davies Air Filter Co., 390 Fourth Ave., New York, N. Y.
Davis Regulator Co., 2541 Washtenaw Ave., Chicago, Ill.
Dayton-Dowd Co., Quincy, Ill.
Dayton Rubber Mfg. Co., 2345 W. Riverview Ave., Dayton, O.
Dean Hill Pump Co., 2300 St. Charles St., Anderson, Ind.
De Bothezat Corp., 100—6th Ave., New York, N. Y.
Decatur Pump Co., Decatur, Ill.
● Delco Products Corp., Dayton, O.
De Laval Steam Turbine Co., Trenton, N. J.
De La Vergne Engine Co., Sales Agent for Baldwin Southwark Corp., Philadelphia, Pa.
Deming Co., Salem, O.
d'Este Co., Julian, Corner Cambridge & Spice Sts., Boston, Mass.
Detroit Brass & Malleable Wks., 100 S. Campbell, Detroit, Mich.
● Detroit Lubricator Co., 5842 Trumbull Ave., Detroit, Mich.
Devlin Mfg. Co., Thos., Burlington, N. J.
Diamond Chain & Mfg. Co., 410 Kentucky Ave., Indianapolis, Ind.
Diamond Mfg. Co., 243 W. Eighth St., Wyoming, Pa.
Diehl Manufacturing Co., Trumbull St., Elizabethport, N. J.
Dixie Mfg. Co., Inc., 1310 Russell St., Baltimore, Md.
Dodge Mfg. Co., Mishawaka, Ind.
Dow Chemical Co., Midland, Mich.
Dracco Corp., 4063 E. 116th St., Cleveland, O.
Dresser Mfg. Co., S. R., Fisher Ave., Bradford, Pa.
Drying Systems, Inc., 1800 Foster Ave., Chicago, Ill.
Dumore Co., 14th & Racine Sts., Racine, Wis.
Dunham Co., C. A., 450 E. Ohio St., Chicago, Ill.
Duriron Co., Inc., 450 N. Findlay St., Dayton, O.
Dusinberre Indicator Co., 101 Quentin St., Kew Gardens, N. Y.

E

Eagle-Picher Sales Co., Temple-Bar Bldg., Cincinnati, O.
Eagle Signal Corp., Moline, Ill.
Economy Equipment Co., 6835 Wentworth Ave., Chicago, Ill.
Economy Pumping Mchry. Co., 3431 W. 48th Pl., Chicago, Ill.
Edward Valve & Mfg. Co., 1200 W. 145th St., East Chicago, Ind.
Ehret Magnesia Mfg. Co., Valley Forge, Pa.
Electric Controller & Mfg. Co., 2700 E. 79th St., Cleveland, O.
Electric Valve Mfg. Co., Inc., 68 Murray St., New York, N. Y.
Electrovent Fan & Mfg. Co., 737 W. Washington Blvd., Chicago, Ill.
Elliott Co., Jeannette, Pa.
Ellison Draft Gage Co., 214 W. Kinzie St., Chicago, Ill.
● Emerson Electric Mfg. Co., 2018 Washington Ave., St. Louis, Mo.
Engelhard, Inc., Chas., 90 Chestnut St., Newark, N. J.
Erdle Perforating Company, 171 York St., Rochester, N. Y.
Erie City Iron Wks., 1500 East Ave., Erie, Pa.
Esterline-Angus Co., Box 596, Indianapolis, Ind.

F

Fafnir Bearing Co., Booth St., New Britain, Conn.
● Fairbanks Co., 396 Lafayette St., New York, N. Y.
Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill.
● Fedders Mfg. Co., Inc., 57 Tonawanda St., Buffalo, N. Y.

Fee and Stemwedel, Inc., 219 W. Chicago Ave., Chicago, Ill.
Ferro-Nil Corp., 500 Fifth Ave., New York, N. Y.
Filtrine Mfg. Co., Inc., 53 Lexington Ave., Brooklyn, N. Y.
Firestone Tire & Rubber Company, Akron, O.
Fir-Tex Insulating Board Co., St. Helens, Ore.
Fisher Governor Co., 102-17 S. First St., Marshalltown, Ia.
Fitz Gibbon & Crisp, Inc., Trenton, N. J.
Fluor Corp., 909 E. 59th St., Los Angeles, Cal.
Follansbee Bros. Co., 3rd & Liberty Aves., Pittsburgh, Pa.
Foster Pump Works, Inc., 50 Washington St., Brooklyn, N. Y.
Foster Wheeler Corp., 165 Broadway, New York, N. Y.
Foxboro Co., Neponset Ave., Foxboro, Mass.
Frederick Iron and Steel Co., Frederick, Md.
● Fretz-Moon Tube Co., Inc., Butler, Pa.
● Frick Co., W. Main St., Waynesboro, Pa.
● Friez & Sons, Inc., Julien P., 4 N. Central Ave., Baltimore, Md.
Frigidaire Corp., Dayton, O.
Fulton Sylphon Co., Knoxville, Tenn.

G

G & O Mfg. Co., 142 Winchester Ave., New Haven, Conn.
Garden City Fan Co., 332 S. Michigan Ave., Chicago, Ill.
Gates Rubber Co., 999 S. Broadway, Denver, Col.
Gatke Corp., 228 N. La Salle St., Chicago, Ill.
● General Electric Co., 1 River Rd., Schenectady, N. Y.
● General Insulating & Mfg. Co., Alexandria, Ind.
General Insulating Products Co., 8821 15th Ave., Brooklyn, N. Y.
General Refrigeration Sales Co., Shirland Ave., Beloit, Wis.
Geuder, Paeschke & Frey Co., W. St. Paul Ave. & N. 15th St., Milwaukee, Wis.
Gilmer Company, L. H., Keystone & Cottman Sts., Philadelphia, Pa.
Goulds Pumps, Inc., Seneca Falls, N. Y.
Grabler Mfg. Co., 6565 Broadway, Cleveland, O.
Granite City Steel Co., 20th & Madison Ave., Granite City, Ill.
Graton & Knight Mfg. Co., 356 Franklin St., Worcester, Mass.
Greene Gas Cleaner Co., 1600 Union Trust Bldg., Cleveland, O.
Grinnell Co., Inc., 260 W. Exchange, Providence, R. I.
Griscom-Russell Co., 285 Madison Ave., New York, N. Y.
Gulf States Steel Co., Brown-Marx Bldg., Birmingham, Ala.

H

Haering Co., D. W., 3408 W. Monroe St., Chicago, Ill.
Harnischfeger Corp., 4400 W. National Ave., Milwaukee, Wis.
Harrington & King Perforating Co., 5655 Fillmore St., Chicago, Ill.
Harrisburg Fdry. & Mach. Co., Inc., Harrisburg, Pa.
Hart & Cooley Mfg. Co., 61 W. Kinzie St., Chicago, Ill.
Hart Mfg. Co., 115 Bartholomew Ave., Hartford, Conn.
Hartzell Propeller Fan Co., Piqua, O.
Hays Corp., P. O. Box 299, Michigan City, Ind.
● Hays Mfg. Co., Liberty & 12th Sts., Erie, Pa.
H-B Instrument Co., 2518 N. Broad St., Philadelphia, Pa.
Hendrick Mfg. Co., Carbondale, Pa.
Higgin Mfg. Co., Newport, Ky.
Hill Co., E. Vernon, 121 N. Clark St., Chicago, Ill.
Hitchen Engineering Co., Inc., 155 E. 44th St., New York, N. Y.
● Hoffman Specialty Co., Inc., Waterbury Natl. Bank Bldg., Waterbury, Conn.
● Holtzer-Cabot Electric Co., 125 Amory St., Roxbury, Boston, Mass.
Homestead Valve Mfg. Co., P. O. Box 284 A., Coraopolis, Pa.
Horton Mfg. Co., 3016 University Ave., S. E., Minneapolis, Minn.
Hough Co., Janesville, Wis.
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Pa.
Howe Ice Machine Co., 2825 Montrose Ave., Chicago, Ill.
Howell Electric Motors Co., Howell, Mich.
Hugo Mfg. Co., 49 Ave., W., & Superior St., West Duluth, Minn.
Humidi-Cooler Corp., 72 Water St., West Haven, Conn.
Humidity Control Co., 318 North E. St., Tacoma, Wash.
Hussey & Co., C. G., 2850 Second Ave., Pittsburgh, Pa.
Hyatt Roller Bearing Co., Harrison, N. J.
Hydrozone Co., Inc., 10 E. 40th St., New York, N. Y.

I

Ideal Electric & Mfg. Co., East 1st & Oak Sts., Mansfield, O.
Ilg Electric Ventilating Co., 2850 N. Crawford Ave., Chicago, Ill.
Illinois Engineering Co., 1168 W. 21st St., Chicago, Ill.
Illinois Malleable Iron Co., 1801 Diversey Ave., Chicago, Ill.
Imperial Electric Co., Ira Ave., Akron, O.
Independent Air Filter Co., 215 W. Ohio St., Chicago, Ill.
● Independent Register & Mfg. Co., 3757 E. 93rd St., Cleveland, O.
Industrial Dryer Corp., Stamford, Conn.
● Ingersoll-Rand, 11 Broadway, New York, N. Y.
Ingersoll Steel & Disc Co., 310 S. Michigan Ave., Chicago, Ill.
Inland Steel Co., 38 S. Dearborn St., Chicago, Ill.
Insulite Co., 1100 Builders Exchange Bldg., Minneapolis, Minn.
International Engineering, Inc., 1145 Bolander Ave., Dayton, O.
International Moistening Co., 36 Exchange Place, Providence, R. I.
International Nickel Co., 67 Wall St., New York, N. Y.
International Vermiculite Co., 11th & Stanford Ave., Springfield, Ill.

J

Jackson Moistening Co., Fall River, Mass.
Janette Mfg. Co., 556 W. Monroe St., Chicago, Ill.
Jarecki Mfg. Co., 12th & Weschler Ave., Erie, Pa.
Jeffrey Mfg. Co., 956 N. 4th St., Columbus, O.
● Jenkins Bros., 80 White St., New York, N. Y.
Jenkins Mfg. Co., 25 W. 45th St., New York, N. Y.
Johns-Manville, 22 E. 40th St., New York, N. Y.
Johnson Regulator Co., Emil T., 6435 N. Talman Ave., Chicago, Ill.
● Johnson Service Co., 507 E. Michigan St., Milwaukee, Wis.
Johnson Tool Co., 65-67 Massasoit Ave., East Providence, R. I.
Jones Foundry Machine Co., W. A., 4401 W. Roosevelt Rd., Chicago, Ill.
Jones & Laughlin Steel Corp., 311 Ross St., Pittsburgh, Pa.
Jordan & Co., Paul R., 631 S. Delaware St., Indianapolis, Ind.

K

Kaiser Co., H. S., 936 W. Chicago Ave., Chicago, Ill.
Kane Mfg. Co., Kane, Pa.
Kant Klog Nozzle Co., 1625 Cleveland, Kansas City, Mo.
Kauffman Air Conditioning Corp., 4485 Olive St., St. Louis, Mo.
Kaye & McDonald, Inc., 94 Franklin St., West Orange, N. J.
Keasbey & Mattison Co., Butler Ave., Ambler, Pa.
Keckley Co., O. C., 565 Washington Blvd., Chicago, Ill.
● Kelvinator Corp., 14250 Plymouth Rd., Detroit, Mich.

Kennedy Valve Mfg. Co., Elmira, N. Y.
Kerotest Mfg. Co., 2525 Liberty Ave., Pittsburgh, Pa.
Kieley & Mueller, Inc., 34 W. 13th St., New York, N. Y.
Kimball Krogh Pump Co., 1010 E. 62nd St., Los Angeles, Cal.
Kinetic Chemicals, Inc., 10th & Market St., Wilmington, Del.
King Ventilating Co., Owatonna, Minn.
Kirk & Blum Mfg. Co., 2838-52 Spring Grove Ave., Cincinnati, O.
Kleenaire Corp., 409 Jefferson St., Stevens Point, Wis.
Klipfel Mfg. Co., 2651 W. Harrison St., Chicago, Ill.
Knowles Mushroom Ventilator Co., 41 N. Moore St., New York, N. Y.
Korfund Co., 48-15 32nd Pl., Long Island City, N. Y.
Kraisel Co., Inc., 620 Main St., Hackensack, N. J.

L

Larkin Refrigerating Corp., 519 Fair St., S. E., Atlanta, Ga.
Lawler Automatic Controls, 453 N. MacQuesten Pkwy., Mount Vernon, N. Y.
Lawrence Pump & Engine Co., P. O. Box 70, Lawrence, Mass.
Lecourtenay Co., 5 Maine St., Newark, N. J.
Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.
Leffel & Co., James, Springfield, O.
Lehigh Fan & Blower Co., Front & Linden Sts., Allentown, Pa.
Leland Electric Co., 1501 Webster St., Dayton, O.
Lewis Air Conditioners, Inc., 1600 Broadway, N. E., Minneapolis, Minn.
Lewis & Co., Chas. S., 2207 Pine St., St. Louis, Mo.
Lincoln Electric Co., 12818 Coit Rd., Cleveland, O.
Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.
Liquid Carbonic Corp., 3100 S. Kedzie Ave., Chicago, Ill.
Lord Mfg. Co., Erie, Pa.
Ludlum Steel Co., Watervliet, N. Y.
Luken Steel Co., S. First Ave., Coatesville, Pa.
Lunkenheimer Co., Waverly & Beekman Sts., Cincinnati, O.
Lytton Mfg. Corp., 102 First Ave., Franklin, Va.

M

Malleable Iron Fittings Co., Branford, Conn.
Manhattan Rubber Mfg., Div. of Raybestos-Manhattan, Inc., 61 Willett St., Passaic, N. J.
Marathon Electric Mfg. Corp., Plumer's Island, P. O. Box 440, Wausau, Wis.
Marble-Card Electric Co., Gladstone, Mich.
Marley Co., 1915 Walnut St., Kansas City, Mo.
Marsh Corp., Jas. P., 2073 Southport Ave., Chicago, Ill.
Martin-Parry Corp., W. Market St., York, Pa.
Martocello & Co., Jos. A., 229 N. 13th St., Philadelphia, Pa.
Masonite Corp., 111 W. Washington St., Chicago, Ill.
Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass.
Master Electric Co., 100 Davis Ave., Dayton, O.
Maxim Silencer Co., 410 Asylum St., Hartford, Conn.
McAlear Mfg. Co., 1901 S. Western Ave., Chicago, Ill.
McCord Radiator & Mfg. Co., 2587 E. Grand Blvd., Detroit, Mich.
McCormick & Co., Foot of Susquehanna St., Williamsport, Pa.
Medart Co., 3500 De Kalb, St. Louis, Mo.
Meier Electric & Machine Co., 3525 E. Washington St., Indianapolis, Ind.
Merchant & Evans Co., 2035 Washington Ave., Philadelphia, Pa.
Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.
Metalace Corp., 60 K St., South Boston, Mass.
Metropolitan Refining Co., Inc., 23-28 50th Ave., Long Island City, N. Y.
Midwest Piping & Supply Co., 1450 Second St., St. Louis, Mo.
Miller & Connell Co., 1454-56 N. Claremont Ave., Chicago, Ill.
Milwaukee Valve Co., 2355 Burrell St., S., Milwaukee, Wis.
Mineral Felt Co., 2284 Albion St., Toledo, O.
● Minneapolis-Honeywell Regulator Co., 2701 Fourth Ave. South, Minneapolis, Minn.
Mitchell Moulding Co., 1501-15 Circle Ave., Forest Park, Ill.
● Modine Mfg. Co., 1750 Racine St., Racine, Wis.
Monarch Mfg. Works, Inc., Salmon & Westmoreland Sts., Philadelphia, Pa.
Monarch Metal Weatherstrip Co., 6333 Etzel Ave., St. Louis, Mo.
Monmouth Products Co., 221 East 131st St., Cleveland, O.
Montgomery Bros., 61 Fremont St., San Francisco, Cal.
Morris Machine Wks., 20 E. Genesee St., Baldwinsville, N. Y.
Morse Chain Co., Ithaca, N. Y.
Moto Meter Gauge & Equipment Corp., La Crosse, Wis.
● Mueller Brass Co., Port Huron, Mich.
Mueller Steam Specialty Co., 351 W. 26th St., New York, N. Y.
● Mundet Cork Corp., 450 7th Ave., New York, N. Y.
Murray Iron Works Co., 1106 Washington St., Burlington, Ia.
Myers Electric Co., 424 Fourth Ave., Pittsburgh, Pa.

N

● Nash Engineering Co., South Norwalk, Conn.
Nash Refrigeration Co., Inc., Summit, New and Bleecker Sts., Newark, N. J.
Nason Mfg. Co., 71 Fulton St., New York, N. Y.
National Asbestos Mfg. Co., 163-193 Henderson St., Jersey City, N. J.
National Regulator Co., 2301 N. Knox Ave., Chicago, Ill.
National Tube Co., Frick Bldg., P. O. Box 132, Pittsburgh, Pa.
Nelson Corp., Herman, 1824 3rd Ave., Moline, Ill.
Nesbitt, Inc., John J., State Rd. & Rhown St., Philadelphia, Pa.
New Departure Mfg. Co., Bristol, Conn.
New Haven Copper Co., Seymour, Conn.
Newport Rolling Mill Co., Ninth & Lowell Sts., Newport, Ky.
Niagara Blower Co., 6 E. 45th St., New York, N. Y.
Nicholson & Co., W. H., 137 Oregon St., Wilkes-Barre, Pa.
● Norma-Hoffmann Bearings Corp., Stamford, Conn.
Norristown Magnesia & Asbestos Co., Washington St., Norristown, Pa.
Northern Indiana Brass Co., P. O. Box 455-935 Plum St., Elkhart, Ind.
Northern Weatherstrip Co., 367 S. 1st Ave., East, Duluth, Minn.

O

Oberdorfer Brass Co., M. L., 2307 Thompson Rd., Syracuse, N. Y.
Ohio Electric Mfg. Co., 5910 Maurice Ave., Cleveland, O.
Orr & Sembower, Inc., Reading, Pa.
Otis Steel Co., Jennings Rd., Cleveland, O.
● Owens-Illinois Glass Co., Industrial Materials Div., Toledo, O.
Ozone Pure Airifier Co., 1455 W. Congress St., Chicago, Ill.

P

Palmer Co., 267 Clay St., Cincinnati (St. Bernard), O.
Palmer Electric Co., 1258 Park Pl., Detroit, Mich.
Pangborn Corp., Pangborn Blvd., Hagerstown, Md.
Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Parker Appliance Co., 10320 Berea Rd., Cleveland, O.
Parker-Kalon Corp., 200 Varick St., New York, N. Y.
Parks-Cramer Co., 970 Main St., Fitchburg, Mass.
Patterson Shade Co., 1525 N. Meridian St., Indianapolis, Ind.
Peerless Electric Co., W. Market St., Warren, O.
Peerless Ice Machine Co., 515 W. 35th St., Chicago, Ill.
Penn Spray Tower Wks., 1337 Nixon St., Pittsburgh, Pa.

● Advertisement in this issue. See Index to Advertisers, page 136

Penn Electric Switch Co., 2000 E. Walnut, Des Moines, Ia.
Pennsylvania Engineering Wks., 526 S. Jefferson St., New Castle, Pa.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Perkins & Sons, Inc., B. F., Chicopee St., Holyoke, Mass.
Philadelphia Pipe Bending Co., 4135-65 N. Fifth St., Philadelphia, Pa.
Philadelphia Thermometer Co., 915 Filbert St., Philadelphia, Pa.
Phoenix Brass Fittings Corp., Coit St. & Chancellor Ave., Irvington, N. J.
Phoenix Ice Machine Co., 2711 Church St., Cleveland, O.
Pioneer Heat Regulator Corp., 100 Davis Ave., Dayton, O.
Pittsburgh Equitable Meter Co., 400 N. Lexington Ave., Pittsburgh, Pa.
Pittsburgh Lectrodryer Corp., P. O. Box 1008, Pittsburgh, Pa.
Pittsburgh Piping & Equipment Co., 43rd St. & A. V. R. R., Pittsburgh, Pa.
Pittsburgh Tube Co., Vandergrift Bldg., Pittsburgh, Pa.
Pittsburgh Valve & Fittings Co., Barberton, O.
Pomona Pump Co., 206 E. Commercial St., Pomona, Cal.
Poole Foundry & Machine Co., Woodberry, Baltimore, Md.
Powell Co., Wm., 2521-31 Spring Grove Ave., Cincinnati, O.
Powers Regulator Co., 2720 Greenview Ave., Chicago, Ill.
Practical Instrument Co., 2717 N. Ashland Ave., Chicago, Ill.
Propellair, Inc., 1345 Lagonda Ave., Springfield, O.
Pure Carbonic, Inc., 60 E. 42nd St., New York, N. Y.

Q

Quimby Pump Co., Inc., 340 Thomas St., Newark, N. J.

R

Ramsey Chain Co., Inc., 1029 Broadway, Albany, N. Y.
Randall Graphite Products Corp., 609 W. Lake St., Chicago, Ill.
● Reading Iron Co., 401 N. Broad St., Philadelphia, Pa.
Reading-Pratt & Cady Co., 939 Connecticut Ave., Bridgeport, Conn.
Register & Grille Mfg. Co., 70 Berry St., Brooklyn, N. Y.
Reliance Electric & Engineering Co., Ivanhoe Rd., Cleveland, O.
Reliance Refrigerating Machine Co., 3401 N. Kedzie Ave., Chicago, Ill.
Rempe Co., 340 N. Sacramento Ave., Chicago, Ill.
Republic Rubber Co., Youngstown, O.
● Republic Steel Corp., 335 Market St., Youngstown, O.
Research Corp., Chrysler Bldg., New York, N. Y.
● Revere Copper & Brass, Inc., 230 Park Ave., New York, N. Y.
Reynolds Metal Co., 19 Rector St., New York, N. Y.
Rhoads & Sons, J. E., 35 N. Sixth St., Philadelphia, Pa.
Rhode Island Fittings Co., Hillsgrove, R. I.
Rhode Island Humidifier & Ventilating Co., 99 Chauncy St., Boston, Mass.
Robbins & Meyers Co., Lagonda Ave., Springfield, O.
Robertson Co., H. H., Grant Bldg., Pittsburgh, Pa.
Rock Island Register Co., 2435 5th Ave., Rock Island, Ill.
Rockwood Mfg. Co., 1801-2001 English Ave., Indianapolis, Ind.
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Roller Bearing Co. of America, Whitehead Rd., Trenton, N. J.
Rome-Turney Radiator Co., Canal St., Rome, N. Y.
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Roper Corp., Geo. D., Blackhawk Ave., Rockford, Ill.
Ruberoid Co., 500 Fifth Ave., New York, N. Y.
Ruggles-Klingemann Mfg. Co., 4 Foster Ct., Salem, Mass.
Rumsey Pump Co., Ltd., Seneca Falls, N. Y.
Russell Electric Co., 348 W. Huron St., Chicago, Ill.

S

Sall Mountain Co., 176 W. Adams St., Chicago, Ill.
Sangamo Electric Co., Springfield, Ill.
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Savage Arms Corp., 100 E. 42nd St., New York, N. Y.
Schatz Mfg. Co., Fairview, Poughkeepsie, N. Y.
Schatz Venetian Blinds, Los Angeles, Cal.
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Schwitzer-Cummins Co., 1125 Massachusetts Ave., Indianapolis, Ind.
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Servel, Inc., Evansville, Ind.
Shaw-Perkins Mfg. Co., Oliver Bldg., Pittsburgh, Pa.
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Skidmore Corp., St. Joseph, Mich.
Skinner Engine Co., Erie, Pa.
Smidth & Co., F. L., 225 Broadway, New York, N. Y.
Somers Air Filter Sales Co., 7310 Woodward Ave., Detroit, Mich.
Somers, Inc., H. J., 1984 W. LaFayette Blvd., Detroit, Mich.
Somerville Iron Wks., Somerville, N. J.
South Chester Tube Co., Chester, Pa.
Southworth Machine Co., Portland, Me.
Spang, Chalfant & Co., Clark Bldg., Pittsburgh, Pa.
Spence Engineering Co., 109 E. 41st St., New York, N. Y.
Spencer Thermostat Co., 34 Forest St., Attleboro, Mass.
Spray Engineering Co., 114 Central St., Somerville, Mass.
Sprayo-Flake Co., 56 S. Bay St., Milwaukee, Wis.
Square D Co., 710 S. Third St., Milwaukee, Wis.
Standard Air Conditioning, Inc., 40 W. 40th St., New York, N. Y.
Standard Engineering Wks., 289 Roosevelt Ave., Pawtucket, R. I.
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Standard Thermometer, Inc., 65 Shirley St., Boston, Mass.
Star Electric Motor Co., Bloomfield, N. J.
Stat-Amatic Instrument & Appliance Co., 19 Park Ave., Hartford, Conn.
● Staynew Filter Corp., 13 Leighton Ave., Rochester, N. Y.
Sterling Electric Motors, Inc., Telegraph Rd. at Atlantic Blvd., Los Angeles, Cal.
Stewart Inso Board Corp., P. O. Box 756, St. Joseph, Mo.
Stockham Pipe & Fittings Co., 4100 Tenth Ave., N., Birmingham, Ala.
Strang Air Conditioning Corp., 215 E. 20th St., Kansas City, Mo.
● Streamline Pipe & Fittings Co., Port Huron, Mich.
● Strong, Carlisle & Hammond Co., 1394 W. 3rd St., Cleveland, O.
Struthers Dunn, Inc., 153 N. Juniper St., Philadelphia, Pa.
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Super Radiator Corp., 320 Plymouth Bldg., Minneapolis, Minn.
Superior Sheet Steel Co., Division Continental Steel Corp., Canton, O.
Superstat Co., 38 Walter St., Springfield, Mass.
Swaby Mfg. Co., 2010 Marshall Blvd., Chicago, Ill.
Swedish Venetian Blind Co., 601 W. 26th St., New York, N. Y.

Swartwout Co., 18511 Euclid Ave., Cleveland, O.
Symonds Register Co., 3121 Minnesota Ave., St. Louis, Mo.

T

Taber Pump Co., 272 Elm St., Buffalo, N. Y.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
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Terry Steam Turbine Co., 874 Windsor Ave., Hartford, Conn.
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Thermoid Rubber Co., Trenton, N. J.
Thwing Instrument Co., 3339 Lancaster Ave., Philadelphia, Pa.
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Tork Clock Co., Inc., 33 South St., Mt. Vernon, N. Y.
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Trane Co., 303 S. 11th St., La Crosse, Wis.
Trenton Auto Radiator Wks., 626 Brunswick Ave., Trenton, N. J.
Trimount Rotary Power Co., 398 Whiting Ave., East Dedham, Mass.
Triox Engineering Co., 339 N. Taylor, St. Louis, Mo.
Triumph Ice Machine Co., 110-116 E. 70th, Cincinnati, O.
Troy Engine & Machine Wks., Troy, Pa.
Trumbull Electric Mfg. Co., Woodford Ave., Plainville, Conn.
Truscon Steel Co., Albert St., Youngstown, O.
Tube-Turns, Inc., 405 Herald-Post Bldg., Louisville, Ky.
Tuttle & Bailey, Inc., Corbin Ave., New Britain, Conn.
Typhoon Air Conditioning Co., 252 W. 26th St., New York, N. Y.

U

Unified Air Conditioning Co., 322 W. Michigan St., Duluth, Minn.
Uni-Flo Corp., 4646 Lawton Ave., Detroit, Mich.
Union Fibre Co., Inc., Winona, Minn.
Union Steam Pump Co., Battle Creek, Mich.
Unit Heater & Cooler Co., 1002-1024 Third St., Wausau, Wis.
United Cork Companies, Grant Ave., Lyndhurst, N. J.
United States Gauge Co., 44 Beaver St., New York, N. Y.
United States Gypsum Co., 300 W. Adams St., Chicago, Ill.
United States Ozone Co. of America, Crescent St., Scottdale, Pa.
United States Register Co., Burnham St., Battle Creek, Mich.
Universal Cooler Corp., 7424 Melville, Detroit, Mich.
Uno Ventilator Co., 339 Lincoln Ave., Cliftondale, Mass.
Upson Co., Lockport, N. Y.
U. S. Air Conditioning Corp., 2101 Kennedy St., N. E., Minneapolis, Minn.
U. S. Pressed Steel Products Co., Kalamazoo, Mich.
U. S. Rubber Co., 58th & Broadway, New York, N. Y.

V

Vallen, Inc., 225 Bluff, Akron, O.
Ventilating Products Co., 2800 Cottage Grove Ave., Chicago, Ill.
Viking Pump Co., 4th and State Sts., Cedar Falls, Ia.
● Vilter Mfg. Co., 2124 S. First St., Milwaukee, Wis.
Virginia Smelting Co., West Norfolk, Va.
Vogt Machine Co., Henry, 10th & Ormsby Sts., Louisville, Ky.
Voss Ice Machine Wks., 230, 242-252 E. 122nd St., New York, N. Y.

W

● Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.
WAJ Mfg. Co., 2119 Washington St., Kansas City, Mo.
● Walworth Co., 60 E. 42nd St., New York, N. Y.
Warren Shade Co., Inc., 2905 E. Hennepin Ave., Minneapolis, Minn.
Warren Steam Pump Co., Inc., Warren, Mass.
Water Cooling Tower Co., 4530 Drexel Blvd., Chicago, Ill.
Waterloo Register Co., Waterloo, Ia.
Way Panel Loctor Co., Wollaston, Mass.
Webster & Co., Warren, 17th & Federal Sts., Camden, N. J.
Weil Pump Co., 215-17 W. Superior St., Chicago, Ill.
Weinman Pump Co., 290 Spruce St., Columbus, O.
Weirton Steel Co., Weirton, W. Va.
Westco Pump Corp., Front & Gaines Sts., Davenport, Ia.
Western Venetian Blind Co., 601 W. 26th St., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 619 Frelinghuysen Ave., Newark, N. J.
Wheeler Mfg. Co., C. H., 19th, Lehigh & Sedgley Aves., Philadelphia, Pa.
Wheeling Steel Corp., Wheeling, W. Va.
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Wickwire Spencer Steel Co., 41 E. 42nd St., New York, N. Y.
Wilbin Instrument Corp., 40 E. 34th St., New York, N. Y.
Winchester Repeating Arms Co., 275 Winchester Ave., New Haven, Conn.
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● Wittenmeier Machinery Co., 850-860 N. Spaulding Ave., Chicago, Ill.
Wolverine Tube Co., 1411 Central Ave., Detroit, Mich.
Wood Conversion Co., First National Bank Bldg., St. Paul, Minn.
Worthington Pump & Machinery Corp., Harrison, N. J.
Wright-Austin Co., 315 W. Woodbridge St., Detroit, Mich

X

X L Refrigerating Co., 1834 W. 59th St., Chicago, Ill.

Y

Yale & Towne Mfg. Co., Stamford, Conn.
Yardley Screen & Weather Strip Corp., 142 Parsons Ave., Columbus, O.
Yarnall-Waring Co., 102 E. Mermaid Lane, Chestnut Hill, Philadelphia, Pa.
Yates-American Machine Co., Beloit, Wis.
Yeomans Brothers Co., 1470 Dayton St., Chicago, Ill.
York Ice Machinery Co., York, Pa.
Young Radiator Co., Racine, Wis.
Young Ventilating Co., 2703-07 Woodland Ave., Cleveland, O.
Youngstown Pressed Steel Co., Warren, O.
● Youngstown Sheet and Tube Co., 602 Stambaugh Bldg., Youngstown, O.

Z

Zobell Electric Motor Corp., Garwood, N. J.
Zurn Mfg. Co., J. A., 1801 Pittsburgh Ave., Erie, Pa.

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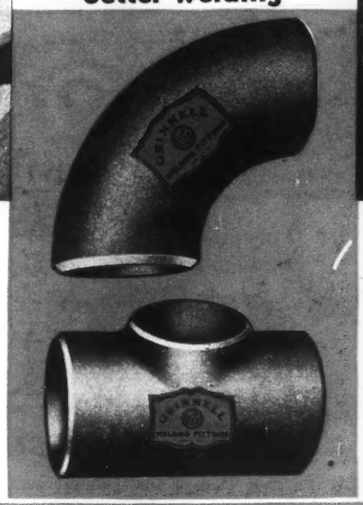

● Heavy, high pressure piping — the arteries of a huge oil refinery; 16 and 10 inch pipe; tremendous heat; that's the picture of this job requiring constant pipe support under conditions which cause pipe expansion and travel up to 2.8 inches.

The solution—Grinnell Genspring Constant Support Hangers. They carry *all* the load *all* the time and eliminate destructive back thrust on the joints. There are no severe strains on the piping, the connections or the apparatus.

Grinnell offers a complete line of adjustable Pipe Hangers and Supports to fit the requirements of every pipe installation from the smallest to the largest.

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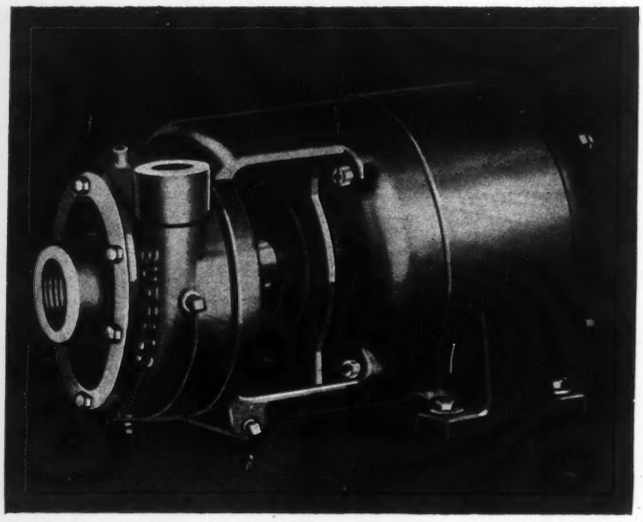
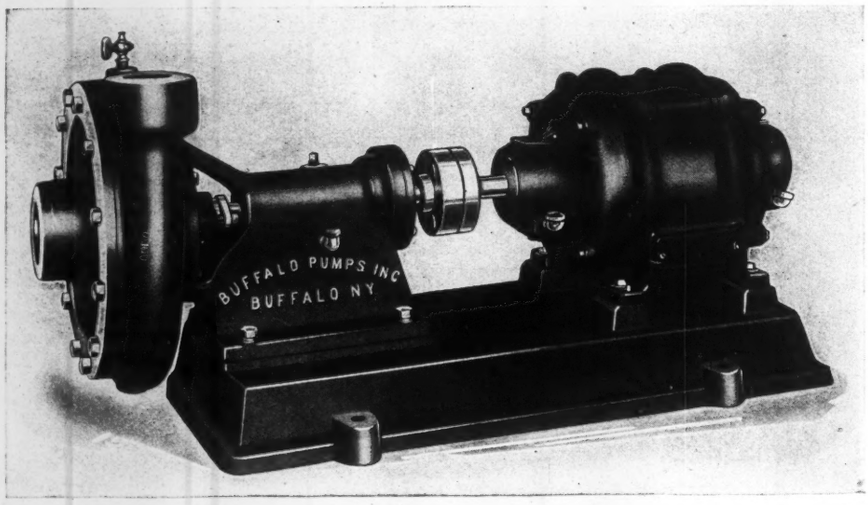


Buffalo Close Coupled Pump for general service work.

Faced with the operating facts, you may be surprised at how much you pay for horsepower on old fashioned, inefficient pumps. The modern, high-speed, high-efficiency Buffalo Pumps shown here may cut your operating costs considerably, and will certainly cost less for maintenance. Why not get data and check up on your pumps, now?



Buffalo Double Ball Bearing Single Suction Pump.

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Up-to-date features described and illustrated in three new bulletins.

No. 975-G	Close-coupled Single Suction Pumps.
No. 976	Double Ball Bearing Single Suction Pumps.
No. 955	Double Suction Pumps.

Buffalo Pumps, Inc.

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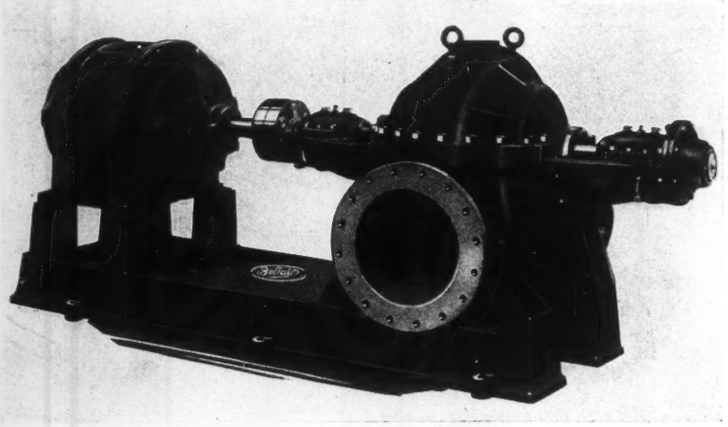
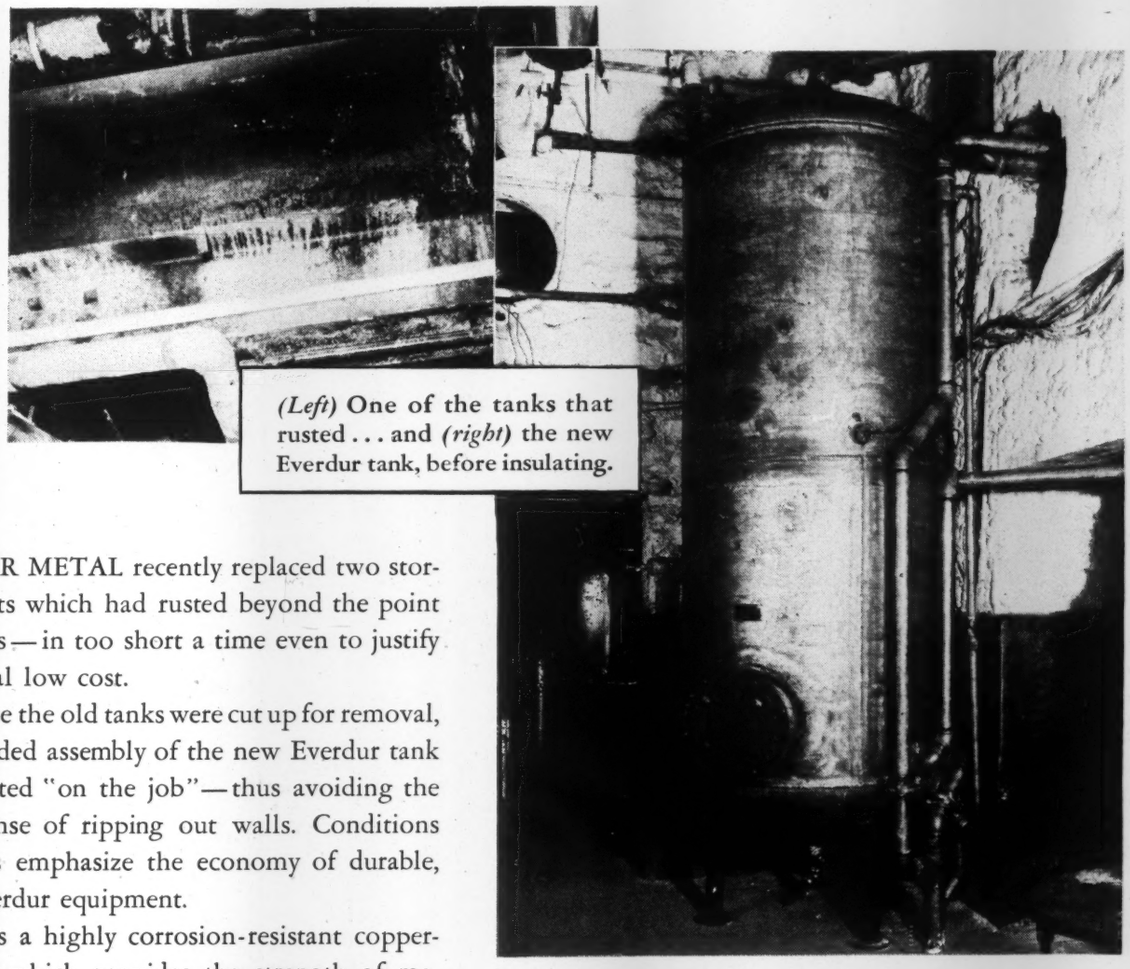


One of the larger Buffalo Double Suction Pumps for general service.

"Buffalo" High Efficiency Centrifugal Pumps

HEATING, PIPING and AIR CONDITIONING, published monthly by Keeney Publishing Co., 6 N. Michigan Ave., Chicago, Ill. Subscription rates: U. S. and possessions, $2.00 per year; Canada, Mexico, Central America, South America, $3.00; other, $4.00. Current copies, U. S. and possessions, 25 cents. Back numbers, 50 cents. December, 1935, Vol. 7, No. 12. Entered as Second Class Matter May, 18, 1929, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Rusted water tanks again replaced with Non-Rust EVERDUR



(Left) One of the tanks that rusted . . . and *(right)* the new Everdur tank, before insulating.

EVERDUR METAL recently replaced two storage units which had rusted beyond the point of usefulness — in too short a time even to justify their original low cost.

In this case the old tanks were cut up for removal, and the welded assembly of the new Everdur tank was completed "on the job" — thus avoiding the added expense of ripping out walls. Conditions such as this emphasize the economy of durable, non-rust Everdur equipment.

Everdur is a highly corrosion-resistant copper-silicon alloy which provides the strength of medium carbon steel. And it is readily welded by all usual methods. The constantly growing popularity of welded Everdur shells finds leading heater manufacturers furnishing this quality equipment in increasing volume. Names of these concerns, and additional data on Everdur, mailed on request.

This all-welded Everdur storage tank, made by WHITLOCK COIL PIPE CO., Hartford, Conn., was installed in connection with a Whitlock "Surtrol" instantaneous heater in the Home of the Daughters of Jacob, New York City.

EVERDUR METAL—"Everdur" is a registered trade-mark identifying products of The American Brass Company made from alloys of copper, silicon and other elements.

ANACONDA
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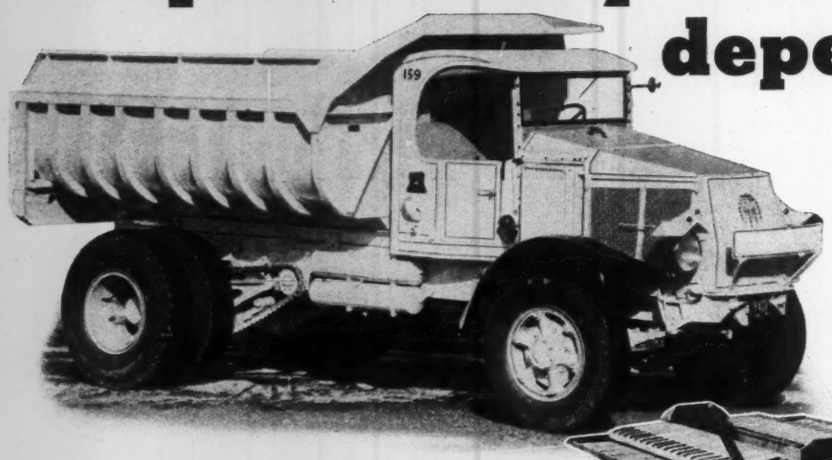
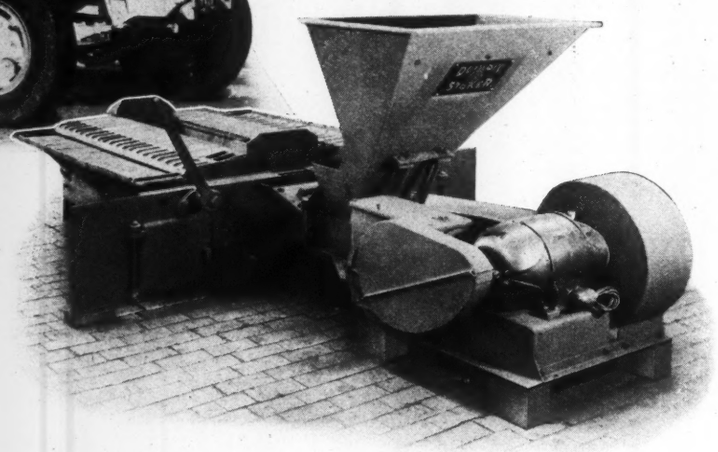
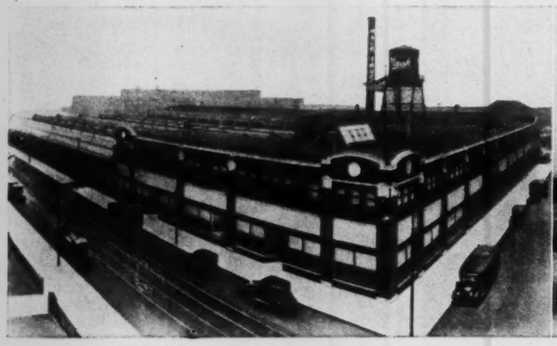


Mack Model A-C, 6-cylinder Bulldog Truck

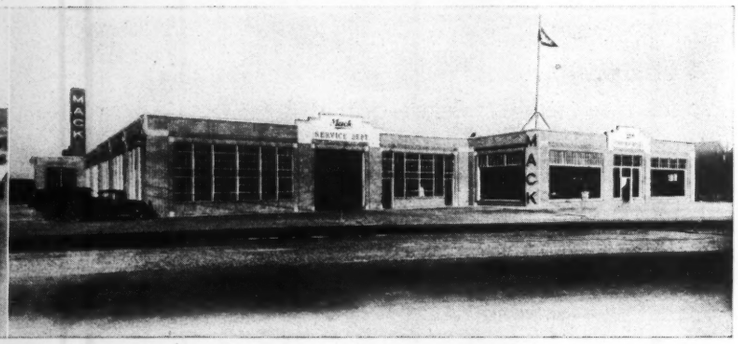
Detroit LoStokers are adjustable plunger feed, side cleaning, and, heavily built for years of continual hard service



Mack Truck uses Detroit LoStokers in 8 Service Plants



Mack Branch at Chicago, Ill., uses Detroit LoStokers



Mack Branch at Bridgeport, Conn.—another Detroit LoStoker installation

Mack Trucks have long enjoyed an enviable reputation for rugged dependability and outstanding performance. It is only natural, therefore, that the International Motor Company, New York City, builders of Mack Trucks and Buses, would use equipment having similar characteristics. Detroit LoStokers have been installed in eight service stations:

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Chicago	St. Paul
New York	White Plains
Newark	Worcester

Andrew J. Morrison, Supervising Engineer
International Motor Co., New York

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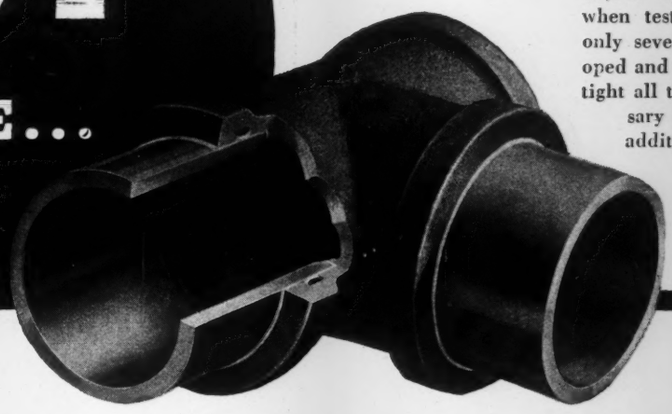
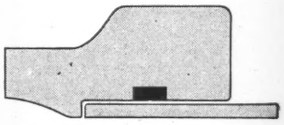
DETROIT SINCE 1898 STOKERS

IT IS EASY TO MAKE...

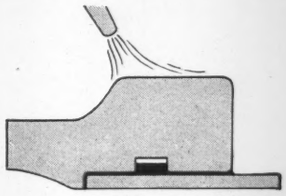


On an installation of Walseal valves and fittings just completed, in which there were over 10,500 Walseal joints, when test was applied only seven leaks developed and to make these tight all that was necessary was to apply additional heat.

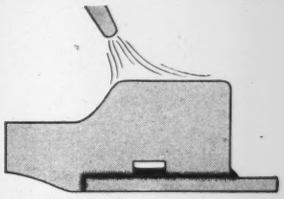
...A PERFECT WALSEAL JOINT



• A ring of Sil-Fos brazing alloy (melting point 1300° F.) of the proper quantity is incorporated in each Walseal Bronze Fitting and Valve.



• The heat of an oxy-acetylene torch applied according to instructions causes the Sil-Fos to flow, completely filling the space between the Walseal fitting and the pipe.



• Sil-Fos impregnates both pipe and fitting making a "one-piece pipe line." The safest and fastest way of making a tight, non-ferrous joint.

First the end of the pipe is cleaned and slightly fluxed. Then the end is slipped into the fitting . . . an oxy-acetylene flame is applied, and when the silver Walseal ring appears you have visible evidence that a perfect joint has been made.

There is no chance of using the wrong brazing alloy with Walseal. Exactly the right amount of "Sil-Fos" brazing alloy is built into every fitting. There is no possibility of having excess alloy plugging the line. The finished Walseal joint — brass or copper — is stronger than the pipe itself. It is proof against vibration, corrosion and creep. It cannot pull apart under any temperature to which brass or copper pipe can safely be raised.

The Walseal Fittings, Flanges and Valves are made for iron-pipe-size brass pipe and extra heavy brass pipe. Walseals can also be used for I.P.S. O.D. thin wall copper tubing (no adapters necessary). They are available in sizes ¼-inch to 8-inch fittings; flanges 1½-inch to 12-inch.

WALWORTH

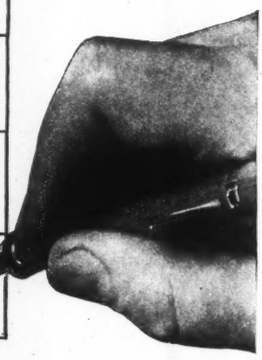
VALVES FITTINGS and TOOLS
Backed by 93 Years' Service

WALWORTH COMPANY
60 EAST 42nd STREET, NEW YORK

DISTRIBUTORS IN PRINCIPAL CITIES THROUGHOUT THE WORLD

Steam Heat . . .

LOW INITIAL COST	✓
FLEXIBLE IN MILD WEATHER	✓
QUICK HEATING	✓
FREEZE - PROOF	✓
PRECISE STEAM BALANCE	✓



Always low in cost . . . always foolproof in operation . . . now adds another great improvement!

HOFFMAN 6-SPEED VENTING

BRINGS INDIVIDUAL RADIATOR CONTROL AND "BALANCED" STEAM DISTRIBUTION TO SIMPLE ONE-PIPE SYSTEMS

In adding up all the advantages of various heating methods, *steam heat still shows a plus value.* The initial cost is low . . . operation most economical . . . and independent of equipment subject to electric current failure or mechanical break-down.

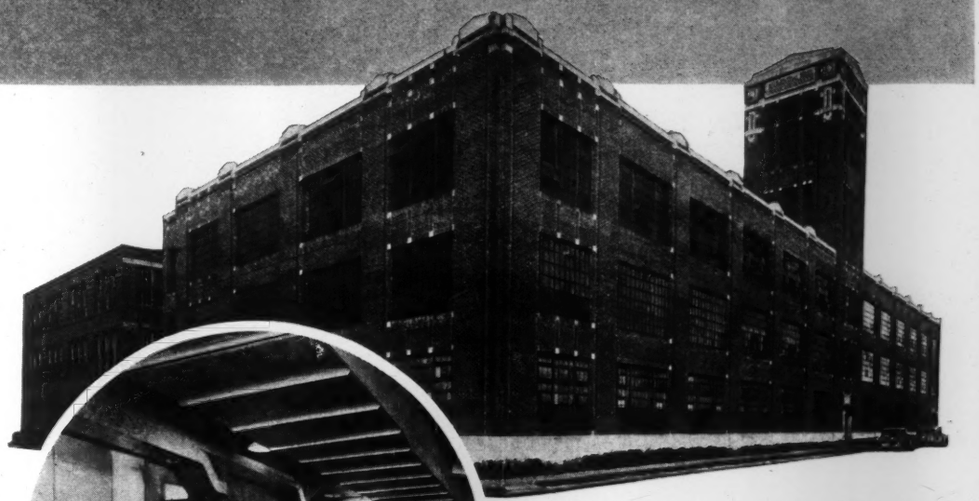
And now—Hoffman Six-Speed Venting Valves give to simple one-pipe systems a feature heretofore found only in more costly two-pipe systems. They provide a means of "balancing" steam distribution so that all radiators will heat equally within the same period. They permit retarding or accelerating the heating of certain radiators, if desirable. Thus a heating system equipped with Hoffman Six-Speed Valves offers a maximum of comfort and economy, yet at a cost within the most modest budget limits.

Only Hoffman Six-Speed Radiator Valves have the visible Vent Port Adjustment which enables either you or the home owner to easily and precisely "balance" the system. If you haven't sent for your free Working Model of the Hoffman Adjustable Orifice Vent Port (patent applied for), write today.

Hoffman Venting Valves and other products are sold everywhere by leading Wholesalers of Heating and Plumbing equipment.

HOFFMAN SPECIALTY CO., Inc.
DEPT. FG-72 WATERBURY, CONN.

LARGE EASTERN CHOCOLATE FACTORY INSULATES WITH CORK FOR MAXIMUM AIR CONDITIONING EFFICIENCY



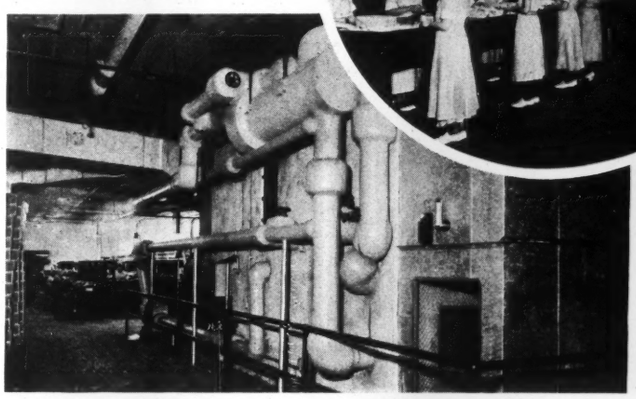
RIGHT:—*Chocolate and cocoa factory of Blumenthal Bros., Philadelphia, Pa., in which working areas 80′ x 100′ on three floors have been air conditioned. Rooms, roof, and equipment are insulated with Armstrong's Cork Insulation, furnished by John R. Livezey, Philadelphia.*

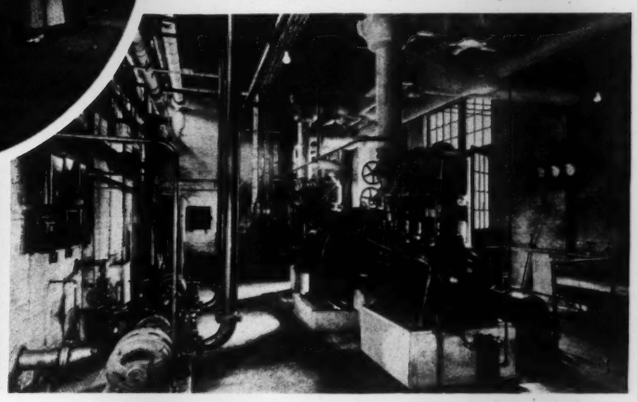
■ ■ ■

BELOW:—*One of the dehumidifiers—capacity, 1500 c. f. p. m. A 2″ thickness of Armstrong's Corkboard insures its efficient operation. Cold lines are insulated with Armstrong's Cork Covering.*

LEFT:—*A temperature of 65° F. and a relative humidity of 50% are maintained in the wrapping and packaging departments which are insulated with Armstrong's Corkboard.*

BELOW:—*New refrigerating machinery in Blumenthal Bros., factory. Brine and ice water lines are insulated with Armstrong's Cork Covering. Canvas covered and painted.*





INSTALLATION of three air conditioning units in the factory of Blumenthal Bros., chocolate and cocoa manufacturers of Philadelphia, Pa., has resulted in practically doubling the producing floor area, and also materially aiding in the manufacture of a better, more uniform product. The work was under the supervision of Josiah H. Smith and Wm. G. R. Braemer, well-known Philadelphia engineers.

To insure maximum operating efficiency of these air conditioning units, 2″ Armstrong's Corkboard was applied on the roof of the building, on the partitions separating air conditioned sections of the plant from those not air conditioned, and to insulate the dehumidifying equipment. In addition, brine thickness cork covering and fitting covers and ice water thickness cork covering and fitting covers were used to insulate cold lines against refrigeration losses.

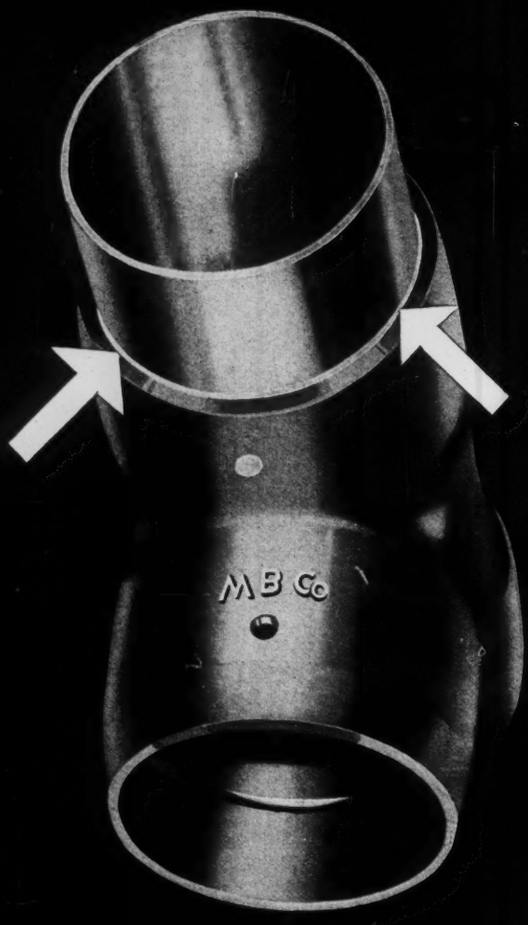
Armstrong's Cork Insulation—Board and Covering—is recognized as the standard insulation for all air conditioning work. For, in addition to its well-known capacity for retarding the passage of heat, this dependable insulation offers another important advantage in its proved ability to permanently withstand the efficiency-destroying effects of moisture . . . to give long years of satisfactory service.

For complete information and samples of Armstrong's Corkboard and Cork Covering, write today to Armstrong Cork Products Company, 994 Concord St., Lancaster, Pennsylvania.

Armstrong's
CORK INSULATION

VISUAL PROOF

OF A PERFECTLY BONDED JOINT



When the fitter feeds the solder into a STREAMLINE Fitting, it furnishes its own visible proof of a leak-proof, perfectly bonded joint—by its appearance as a continuous silver ring at the end of the fitting around the full circumference of the pipe.

This is proof that he can see at a glance, it tells him, beyond all doubt and without resorting to an actual pressure test, that the joint he has just made, will not leak, that vibration cannot loosen it, that it is permanent and actually stronger than the pipe itself.

The solder ring is not mechanically produced by feeding from the end of the fitting —it occurs AUTOMATICALLY as a result of capillarity, which has drawn the solder THROUGH THE FEED HOLE and from the feed channel in the fitting, causing it to distribute evenly between the bonding surfaces —AND TO FLOW OUTWARDS to the end of the fitting.

STREAMLINE pipe and fittings are available in sizes from 1/4-in. to 12-in. They are being successfully used today in hundreds of industrial applications such as stock and paper lines in paper mills, water, beer, wort and "attemperator" piping in breweries, vinegar and fruit juice lines, compressed air lines, etc. They are in widespread use for all lines in hot water heating, for low pressure mains, risers, branches and returns in steam heating systems.

Use STREAMLINE on your next piping job and get the service and savings which its strength, resistance to corrosion and ease of installation provide.

Send for Catalog F.

TRADE MARK

STREAMLINE

REG. U.S. PAT. OFFICE

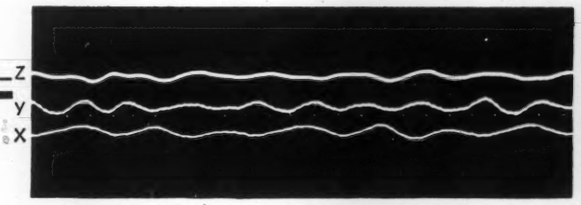
FITTINGS AND COPPER PIPE

STREAMLINE PIPE AND FITTINGS

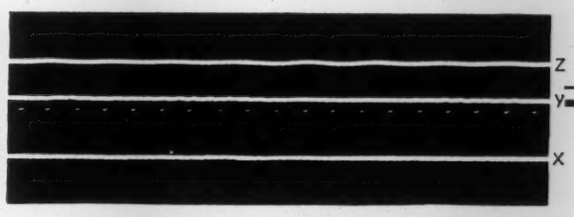
PORT HURON, CO. MICHIGAN

DIVISION OF MUELLER BRASS CO.

SEE HOW VIBRACORK ABSORBS VIBRATION



The vibrograph above gives a graphic picture of the floor slab under a vibrating ventilating fan and motor before Vibracork was installed.



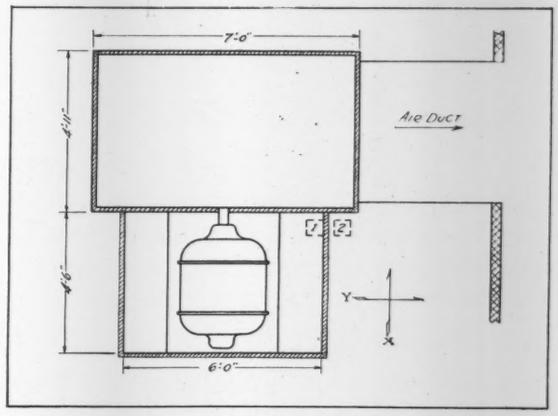
After the Vibracork installation the vibroscope recorded this picture—readings taken at same points. The floor slab is QUIET.

This dependable material can be used for all types of ventilating and air conditioning equipment

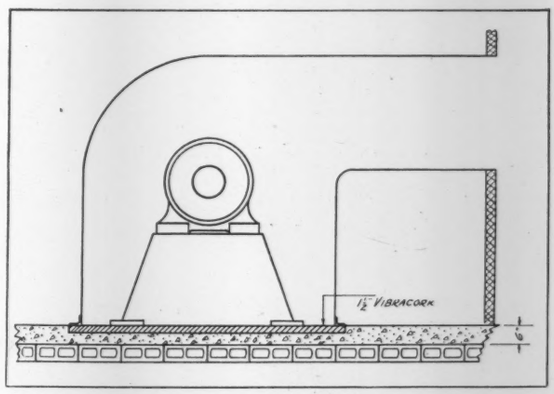
ARMSTRONG'S Vibracork offers an effective way to permanently end the annoyance of vibration transmission. Made of pure cork, this resilient cushion actually absorbs the shocks and jars and quiets the noise of vibrating machines.

Because it is a fabricated product, Armstrong's Vibracork can be made in the proper density and right thickness for any type of ventilating or air conditioning equipment—large or small, heavy or light. Once installed, it insures lasting freedom from vibration nuisance. Even under sustained compression it will not take a "set." Nor will Vibracork deteriorate in service for it is moisture resistant and not subject to rot or decay.

Armstrong's Vibracork is made in three different densities—light, medium, and heavy—to insure materials with the necessary characteristics to accommodate all the machinery isolation problems encountered in ordinary practice. Armstrong engineers are at your service to help you figure on any specific isolation or vibration problem. For more complete information and samples write to Armstrong Cork Products Co., Building Materials Division, 994 Concord St., Lancaster, Pa.



Plan of fan and motor showing location of tests.



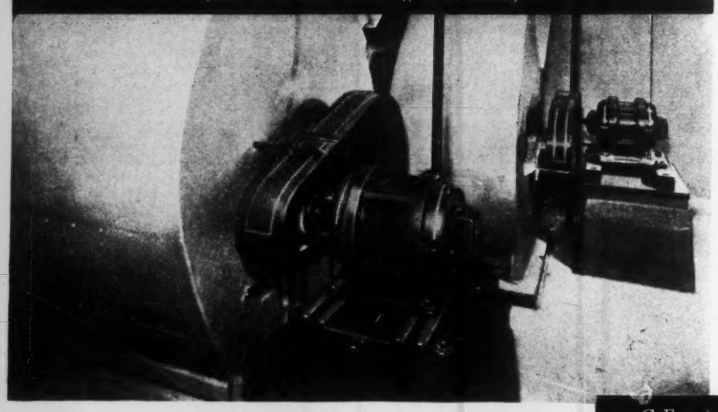
Section showing location of Vibracork and floor construction.

Armstrong's VIBRACORK

The Cork Cushion That Smothers Vibration

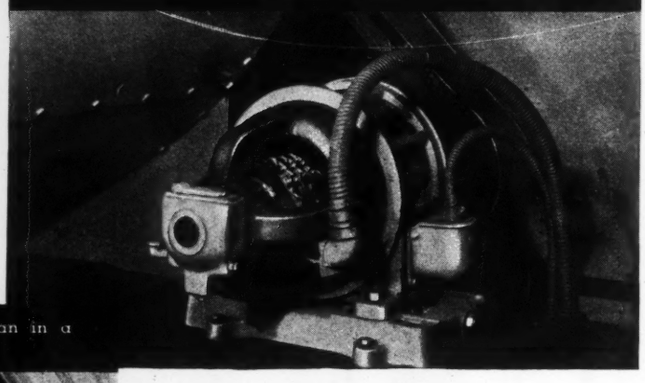
WHICH MOTOR FOR FAN JOBS LIKE THESE ?

Two G-E quiet-operating, squirrel-cage induction motors driving fans in a New York office building



REGARDLESS of the character of your air-conditioning jobs, General Electric can supply the *right* motor to drive your fans economically. In the average fan application, for example, where a large volume of air at low cost is the principal consideration, a G-E squirrel-cage induction motor coupled to your fan will give you economical operation at full output.

G-E quiet-operating, wound-rotor induction motor driving a large ventilating fan in a Chicago auditorium



IN other applications, where it is necessary to control the speed of the motor to meet varying air requirements, a G-E wound-rotor induction motor is the fan drive you should have. These motors are known particularly for their simple, sturdy construction and low operating cost. Like the other G-E motors shown here, the wound-rotor induction type can be either directly coupled to the fan or connected to it by other means.

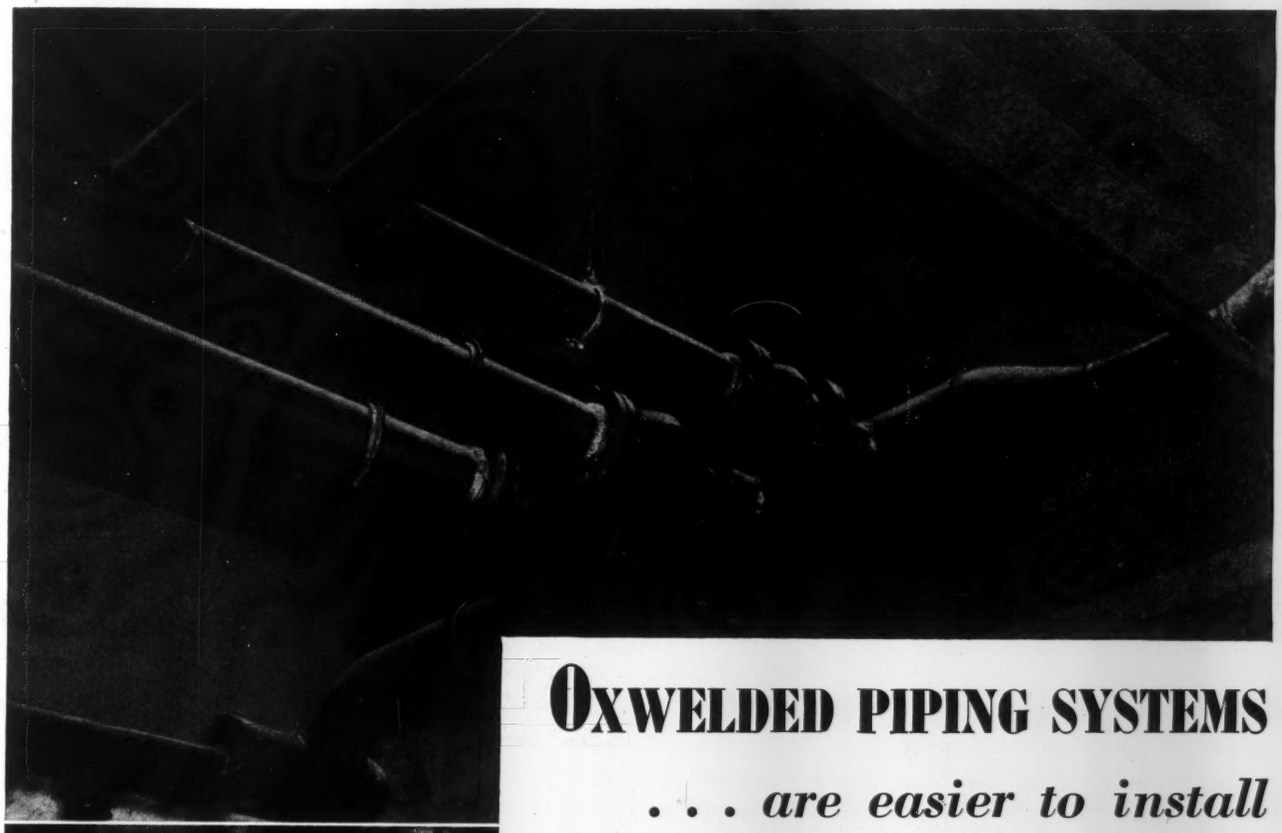
G-E quiet-operating synchronous motor, coupled to a fan in a Detroit bank

THERE are many cases where power-factor improvement is an important consideration in the selection of motors. In such instances, a G-E synchronous motor, with its inherent ability to improve power-factor and its high efficiency over a wide range of loads, will not only give low-cost operation but will help reduce over-all power costs.

From our complete lines of products you can select the* right *electric equipment. General Electric, Schenectady, N. Y.

020-220

GENERAL ELECTRIC



On the installation shown above, the contractor fabricated by oxy-acetylene cutting and welding the bends, reducers, and other specials in his shop and installed them with tie-in welds on the job. The lines and bends were installed with a proximity which would have been impossible by other methods of joining. The insulation contractor estimated a 30 per cent saving on insulation labor because it was a welded installation.

OXWELDED PIPING SYSTEMS

. . . are easier to install and cheaper to maintain

● The economy of oxy-acetylene welded piping for power or domestic and industrial heating purposes extends all along the line. Oxwelded piping systems are cheaper and easier to install, and, once installed they are leakproof and lasting. There are no maintenance expenses on a system put in by this modern process.

Let Linde Help You

The Linde organization can help you with your welded piping projects from the first blue prints to the finish of the actual installation. Linde customers benefit from the closely coordinated research, development and field engineering facilities of the Linde organization. The Linde representative, who assists you as a part of Linde Process Service, makes the results of this research, development and field experience available to your organization.

You can arrange for this cooperation by communicating with the nearest Linde Sales Office or with 30 East 42nd Street, New York, N. Y. Address: The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation.

Everything for Oxy-Acetylene Welding and Cutting

LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES

FROM PRODUCTS OF UNITS OF UCC UNION CARBIDE AND CARBON CORPORATION LINDE UNION CARBIDE

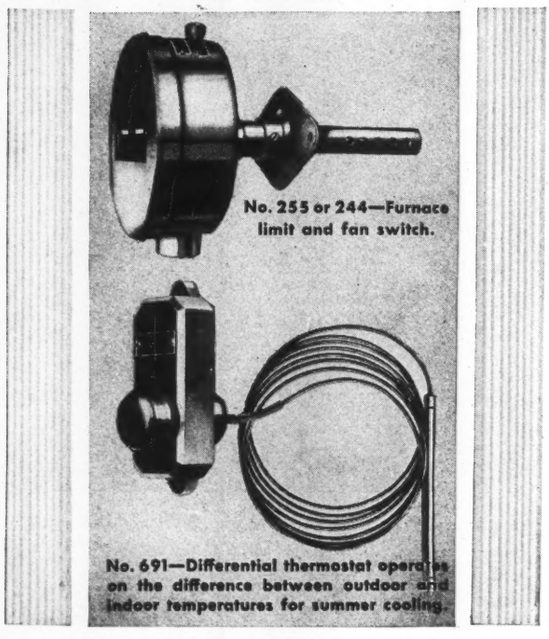
ZONING

The Latest Advance in Forced Air Heating

ZONING permits a better use of heat and better heating plant operation. It assures greater comfort and greater economy for the user. And it offers the dealer another opportunity for profitable business on both old and new installations.

The No. 431 "Genuine Detroit" Duct Damper Motor, has made Zone Heating practicable and thoroughly dependable. The No. 431, which controls both fuel and air supply, may be mounted directly on the heat duct itself without the danger of objectionable noise.

The new mounting bracket materially simplifies installation. The shaft hole is accurately located. No measurements on the job are required.


No. 255 or 244—Furnace
limit and fan switch.
No. 691—Differential thermostat operates
on the difference between outdoor and
indoor temperatures for summer cooling.

The No. 431, in combination with other "Genuine Detroit" Warm Air Controls, gives the user a thoroughly satisfactory installation, and the dealer a worth-while profit.

Write for Bulletin 66

TRADE MARK REG. U.S. PAT. OFF.

DETROIT LUBRICATOR COMPANY

DETROIT, MICHIGAN, U. S. A. NEW YORK, N. Y.—40 West 40th St.

CHICAGO, ILL.—816 S. Michigan Ave. • LOS ANGELES, CALIF.—3251 Wilshire Blvd.

Canadian Representative—RAILWAY AND ENGINEERING SPECIALTIES LIMITED, Montreal, Toronto, Winnipeg

DIVISION OF AMERICAN RADIATOR & STANDARD SANITARY CORPORATION

Drawn for Revere Copper and Brass Incorporated by Edward P. Couse

Call to Meeting

One of Paul Revere's first copper and brass assignments was to recast the bell for the Old North Church, the church where the warning lanterns in the belfry started Revere on his memorable ride to Lexington. When the bell was finished, its tone was so wonderfully clear and true that similar orders came thick and fast. In all, 396 bells were cast for various New England churches; seventy-five of these are known to be still in use. But Revere bells, brass cannon, copper spikes and rivets were soon supplemented by a still greater achievement.

In 1801, Revere mastered the secret for rolling copper, a process never before accomplished in America. Copper sheets from his new mill soon protected the hull of the famous frigate "Old Ironsides," the roof of the Boston State House, and many other public and private buildings up and down the coast.

Paul Revere's ability as a copper and brass manufacturer, inventor, and industrialist is still serving America. Through succeeding generations, the original firm of Paul Revere & Son has grown and consolidated to the present nation-wide organization of Revere Copper and Brass Incorporated.

The Revere heritage of leadership in discovering new applications for copper and brass has also been continued. For example, to meet today's needs in the plumbing, heating and air conditioning industry, Revere offers the following products: Copper Water Tube and Streamline Fittings, Revere Brass Pipe, Red-Brass Pipe, Copper Pipe (S.P.S.), Herculoy, Sheet Copper and Leadtex (lead-coated copper).

We are happy to take this opportunity to wish you a very Merry Christmas and a Bright and Prosperous New Year.

Revere Copper *and* Brass

INCORPORATED

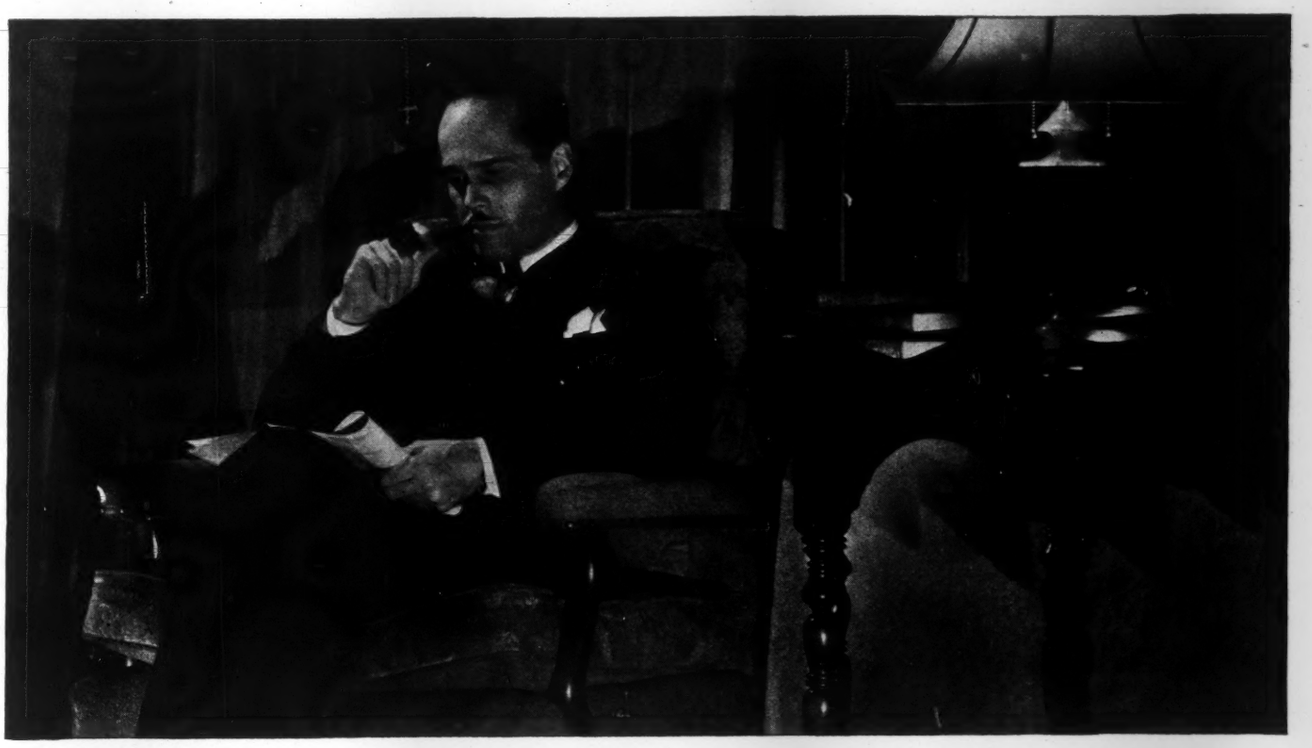
FOUNDED BY PAUL REVERE 1801

EXECUTIVE OFFICES: 230 PARK AVENUE, NEW YORK CITY · MILLS: BALTIMORE, MD. · TAUNTON, MASS.
NEW BEDFORD, MASS. · ROME, N. Y. · DETROIT, MICH. · CHICAGO, ILL. · SALES OFFICES IN PRINCIPAL CITIES

GALVANIZED TRADE MARK YOUNGSTOWN SHEETS

Exceptional care in the galvanizing operation has won for YOUNGSTOWN galvanized sheets a well-deserved reputation for long and economical service. First-time purchasers quickly find their sheet-losses reduced to a minimum because of the tenacity of the bond between coating and base metal.

THE YOUNGSTOWN SHEET AND TUBE COMPANY
Manufacturers of Carbon and Alloy Steels
General Offices - - YOUNGSTOWN, OHIO



You can get some of it out of a Book . . .

but here's an easier way . . . call KELVINATOR!

Kelvinator Engineers have all the *theory* in the world back of them, but they've got something else that's a lot more valuable—*practical experience* with air conditioning.

They have the kind of experience which enables them to analyze a proposed job and tell you whether it will work out efficiently. And that's what you want to know. That's what is worth real money to you.

Air Conditioning is an old story to Kelvinator. Years ago Kelvinator set about building up an Air Conditioning engineering staff, employing men already skilled in such vitally important work as construction, heating, and ventilation, air filtration and refrigeration.

Today this engineering staff is ready to help you—in your office or in the field—ready to give you the benefit of its practical experience as well as placing at your disposal definite facts regarding equipment, installation and costs.

And rememember this—you can depend on Kelvinator. There are 21 years of continuous growth back of this corporation, and it is in Air Conditioning to stay. Call your nearest Kelvinator dealer, or write Kelvinator Corporation, 14250 Plymouth Road, Detroit, Mich. Factories also in London, Ontario and London, England.

KELVINATOR

Specialists in Controlled Temperatures Since 1914

Air Conditioning
Household Refrigeration
Automatic Heating
Water Cooling
Truck Refrigeration
Beverage Cooling
Ice Cream Cabinets
Milk Cooling
Commercial Refrigeration
for every need of merchants, manufacturers and institutions

EXACT SELECTION

WHEN YOU CONSIDER AIR CONDITIONING

call **KELVINATOR**

TANKS *can* last as long as the buildings that hold them!

IN PROCESS INDUSTRIES

Duronze is often used in place of the more expensive corrosion resisting alloys. Its toughness, ease of fabricating, and modest cost make it the logical material for tanks, ducts, flues, air conditioning equipment, etc.

"Duronze Alloys," a booklet with technical information on high strength silicon bronze alloys, will be sent on request.

DURONZE

Here is an ideal tank material . . . tough as steel . . . exceptionally high in tensile strength . . . more corrosion resisting than copper . . . with a high salvage value if it outlives its usefulness. Yet Duronze is remarkably inexpensive.

"Bridgeport" BRASS CO. TRADE MARK

Duronze presents no problem to the tank manufacturers. It is fabricated by the same tools and the same methods as steel. Can be welded readily by either oxy-acetylene, or electric arc methods.

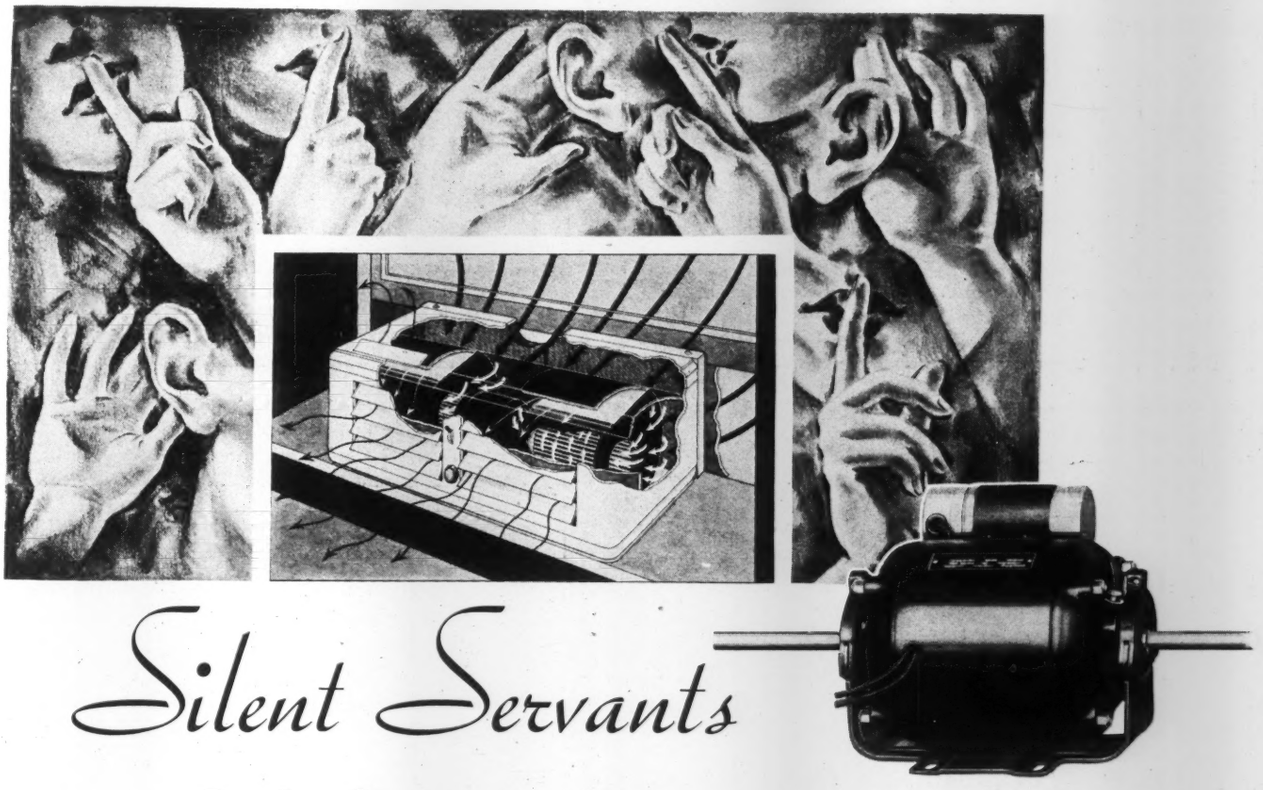
If tank troubles have bothered *you* in the past, in the shape of rust, replacement and interrupted service . . . end them with Duronze. Write for samples and engineering data.

BRIDGEPORT BRASS CO.

Established 1865

BRIDGEPORT **CONNECTICUT**

BRIDGEPORT



Silent Servants

S. A. C. SILENCING VENTILATORS
EMERSON QUIET-BUILT MOTORS

When engineers of Standard Air Conditioning, Inc., New York, set out to design and build the S. A. C. Ventilator, they were keenly aware of the public's demand for the silencing of street noises. In meeting this demand they embodied patented principles of silencing, a method of acoustical construction, that stills nerve-wracking outdoor noises to the point of "closed-window quietness."

And as a finishing touch, to secure mechanical silence and durability—the S. A. C. Ventilator was given a great "heart", a quiet-built, individually engineered Emerson Motor. Together they have established an enviable record — as *Silent Servants.*

If quiet, trouble-free operation is demanded of your product—investigate *Emerson.* Write today for Bulletin 45-P.

QUIET

With nearly 45 years' experience in building the finest motors, Emerson is unusually well equipped to produce Quiet Motors. A soundproof testing laboratory with specially designed scientific equipment, to analyze the complex wave form, is in constant use to insure uniform production of Quiet Motors — yet Emerson Motors are competitively priced.

Visit Emerson Booths Nos. 410-509, International Heating & Ventilating Exposition, Chicago – Jan. 27-31

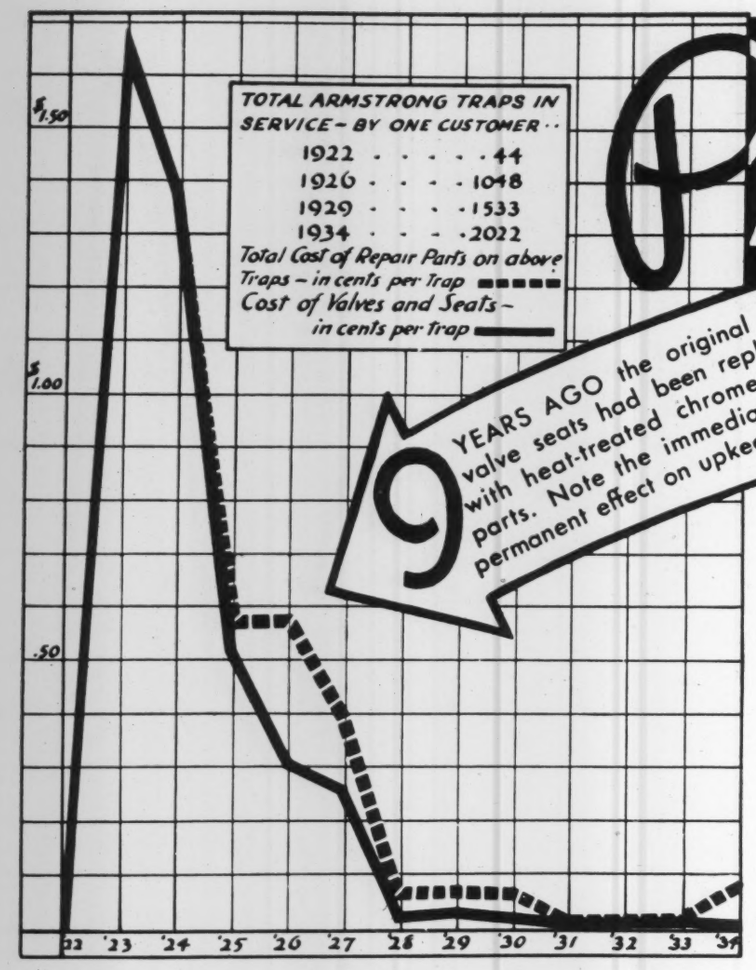
EMERSON MOTORS

3 HP and smaller—Single-phase—Polyphase—Direct Current

THE EMERSON ELECTRIC MFG. CO.

NEW YORK ST. LOUIS CHICAGO

LEADERS IN THE FAN AND MOTOR INDUSTRY SINCE 1890


TOTAL ARMSTRONG TRAPS IN SERVICE – BY ONE CUSTOMER ··
1922 · · · · · 44
1926 · · · · · 1048
1929 · · · · · 1533
1934 · · · · · 2022
Total Cost of Repair Parts on above Traps – in cents per Trap
Cost of Valves and Seats – in cents per Trap
$1.50
$1.00
.50
22 23 24 25 26 27 28 29 30 31 32 33 34
9 YEARS AGO the original soft valve seats had been replaced with heat-treated chrome steel parts. Note the immediate and permanent effect on upkeep costs.

Proof OF LOW UPKEEP COST!

THE chart at left is based on more than 16,500 trap years of service for a single user. The average cost of valves and seats per trap per year for the 13 year period is 15.2 cents and the average cost of all repair parts is 19.4 cents. But the real significance of this chart lies in the decreased costs after the change-over to heat-treated valve parts had been made. The cost per trap per year (from 1928-1934 inclusive) dropped to 3.7 cents for valves and seats and 4.8 cents for the total repair parts. No wonder Armstrong users say you can install these traps and forget them.

There is a size and type of Armstrong trap for every industrial need. Ask for the Armstrong Steam trap book.

FOR nearly 25 years Armstrong traps have been setting a high standard for economy in maintenance. The basic design and the quality of materials and workmanship minimized the need for repairs and about the only replacements were valves and seats. Records of various Armstrong customers show as much as 90% of all maintenance cost represented by such replacements.

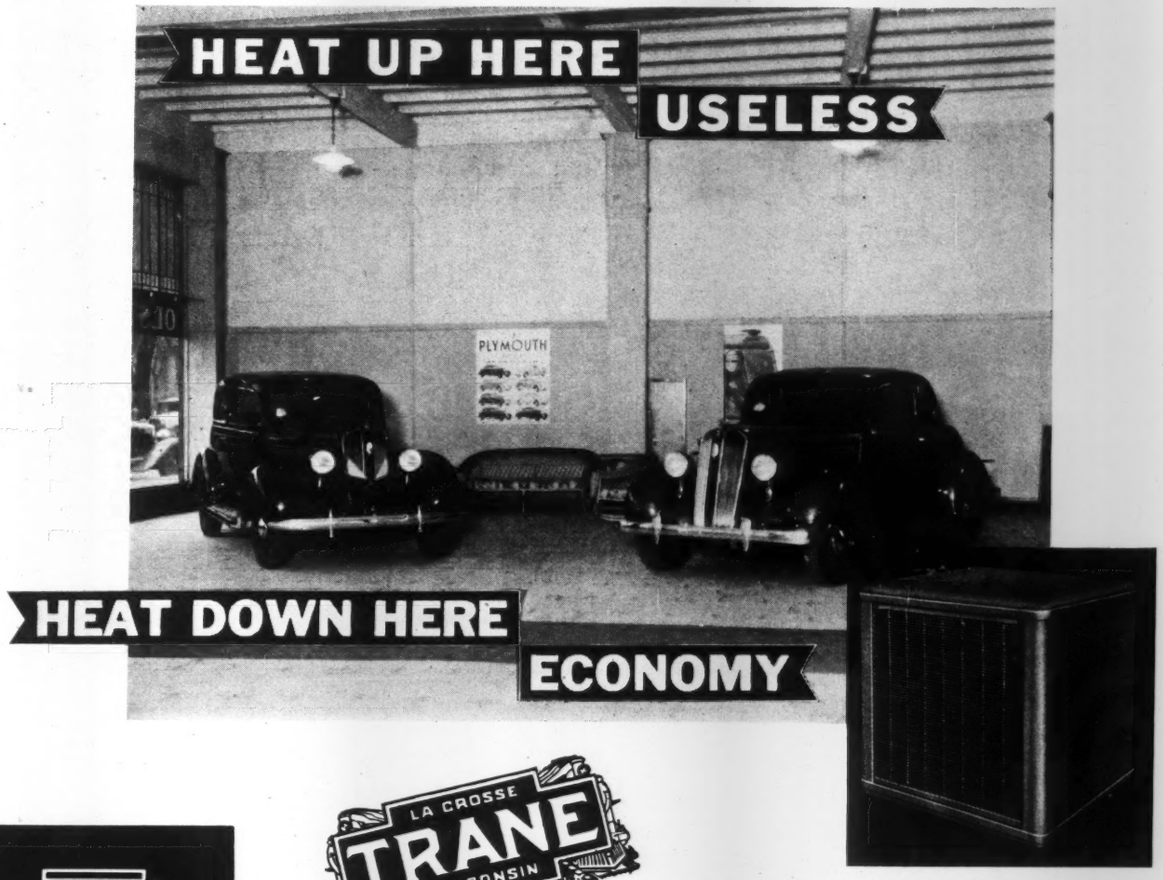
While Armstrong valve parts have always been made of the best available metal, there has been a striking improvement in this direction in the past decade. Phosphor bronze valves used to be considered good—and thousands of Armstrong traps so equipped gave fine records of trouble-free service. But under some conditions bronze would wear rapidly. Special alloys were better but not good enough for Armstrong. By constantly experimenting with heat treatment of chrome steel for the past 12 years, the present standard valve parts were developed. They have no fancy name but their uniform hardness and toughness makes them highly resistant to wear and corrosion. Their close approach to the ideal for long, hard service is best shown by facts and figures.

The chart reproduced above represents the actual maintenance costs on Armstrong traps for one typical large user. This is clear proof of the economy and dependability of Armstrong traps. We still offer our original 90-day free trial of as many Armstrong traps as you want to test.

ARMSTRONG "INVERTED BUCKET" STEAM TRAP

ARMSTRONG MACHINE WORKS

874 Maple Street **Three Rivers, Michigan**



LA CROSSE TRANE WISCONSIN

TRANE UNIT HEATERS PROVIDE ECONOMY HEAT

Your clients want a heating system which will spread heat down in the living zone. That is why TRANE "Floor Line Spread" Unit Heaters are so popular. They spread the heat in the living zone and spread it so effectively that fuel bills will be cut as much as 25 to 30% on many installations.

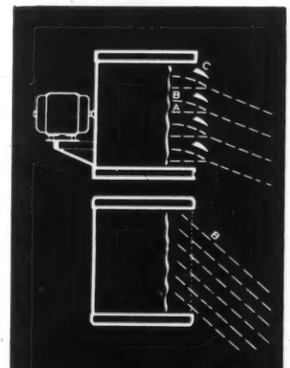
"Floor Line Spread" is an exclusive feature of TRANE Unit Heaters and is one of the chief reasons why TRANE Unit Heaters are the leaders in the space heating field.

Along with the exclusive feature of TRANE "Floor Line Spread" is the famous TRANE Heat Transfer Coil. This combination of two outstanding features is the reason why your clients will respect your recommendations on TRANE Unit Heaters.

There are hundreds of styles and types of TRANE Unit Heaters to meet every heating requirement that you may have. In the Propeller Fan Type there is the De Luxe and UH models; and in the Torridor Series there is a complete range of wall, ceiling and floor model Blower Fan Type Units.

Use the coupon below for complete information on the TRANE Unit Heater line.

The TRANE Company :: La Crosse, Wisconsin



THE difference in heat distribution between a Trane "Floor Line Spread" Unit Heater and the ordinary Unit Heater lies in the elimination of one "force."

Above is the distribution from an ordinary unit heater. Line "A" represents that stream of air which is not affected by the louvre "C". Line "B" represents the stream air that is turned downward by the louvre.

In other words, the stream is controlled by two forces—one attempting to rise, the other being forced upward—A STREAM OF FIGHTING CURRENTS.

Below is a Trane "Floor Line Spread" Unit Heater. Note the absence of Line "A". All of the air is directed towards the floor. ONE FORCE AND THAT DIRECTING THE AIR TO THE FLOOR.

NO COMBAT—
NO FIGHTING CURRENTS

And note the neat, compact appearance that the Trane Freeflo grille brings to the unit—the smartest looking as well as the most efficient unit on the market.

The Trane Company
Dept. HP 12
La Crosse, Wisconsin

Please send complete data on TRANE Unit Heating Systems.

Name .....
City .....
State .....

WATCH FOR IT NEXT MONTH!

It will arrive in a special heavy cover to withstand the wear and tear of the use you will make of it all year as a buying and specifying guide. Read its outstanding articles . . . . be sure to look over the big "Show" Section . . . . and keep it handy on your desk for constant reference to the Directory and advertising pages.

Heating·Piping and Air Conditioning

JANUARY 1936

COMPLETE DIRECTORY OF HEATING, PIPING AND AIR CONDITIONING EQUIPMENT FOR INDUSTRY AND LARGE BUILDINGS

4TH INTERNATIONAL HEATING, VENTILATING AND AIR CONDITIONING EXPOSITION

FULL QUOTA OF EDITORIAL ARTICLES

JOURNAL SECTION
AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

ADVERTISERS NOTE: By wiring your reservation or inquiry you can still make this exceptional advertising opportunity . . . . an issue which will work for you before the big "Show," which will work for you at the "Show" and which will go right on working for you all year long. Deadline for copy is December 20.

TUBE-TURNS★ PERMIT BETTER WELDING

ANY man who's ever handled a torch will tell you that the quickest, strongest welds are the ones that join two pieces of *identical* pipe—or a pipe and a Tube-Turn.

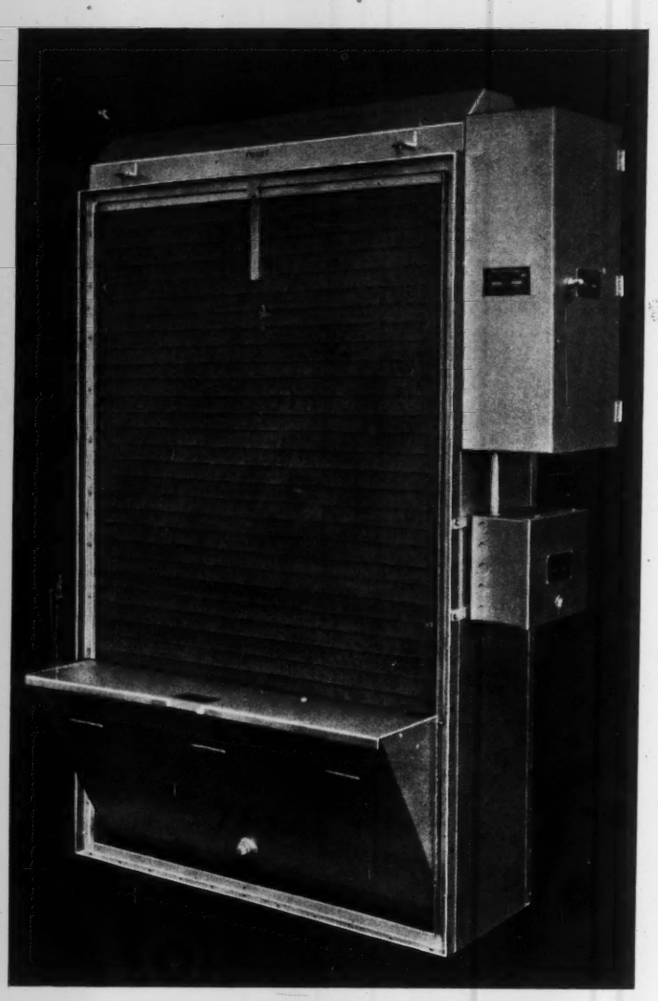
Why the latter? Because the Tube-Turn is in no way different from the pipe except that it isn't straight. (1) It is made of the same material. (2) It has the same wall-thickness as the pipe—matches the pipe in both I. D. and O. D.

If you think these are small points, just run time and strength comparisons on *other* kinds of weld! Tube-Turns, Incorporated, Louisville, Ky.

★ The word "Tube-Turn" is NOT a general name for welding fittings. It is the copyrighted name of the seamless fittings having uniform wall-thickness at all points, true circular cross-section, uniform radius of curvature and smooth inner walls. Made ONLY by Tube-Turns, Incorporated.

Multi-Panel

. . . Known By The Company It Keeps



A Few Recent MULTI-PANEL Installations

W. G. N. Studios	Chicago	32,000 C.F.M.
Lexington Building	Baltimore	22,000 C.F.M.
Carew Tower	Cincinnati	55,000 C.F.M.
John Wanamaker Store	New York City	52,000 C.F.M.
John Wanamaker Store	Philadelphia	80,000 C.F.M.
Municipal Auditorium	St. Louis	25,000 C.F.M.
Children's Hospital	Denver	13,000 C.F.M.
Metropolitan State Hosp.	Waltham	35,000 C.F.M.
Seattle City Light Co.	Seattle	52,000 C.F.M.
Monson State Hospital	Monson	12,000 C.F.M.
Penny Store	Milwaukee	42,000 C.F.M.
Federal Reserve Bank	Cleveland	60,000 C.F.M.
Federal Reserve Bank	New York City	50,000 C.F.M.
University of Chicago	Chicago	72,000 C.F.M.
First National Bank	Baltimore	40,000 C.F.M.
University Hospital	Baltimore	20,000 C.F.M.
University of Wash. Library	Seattle	70,000 C.F.M.
Stewart & Company	Baltimore	64,000 C.F.M.
Chemistry Bldg. U. of Cal.	Los Angeles	59,000 C.F.M.
Equitable Building	Des Moines	80,000 C.F.M.
Deerfield Shields School	Lake Forest	29,000 C.F.M.
Fernald State School	Boston	20,000 C.F.M.
Carson-Pirie-Scott Co.	Chicago	40,000 C.F.M.
Union News Co. (Radio City)	New York City	13,000 C.F.M.
Oriole Cafeteria	Baltimore	18,000 C.F.M.
Alameda County Ct. House	Oakland	148,000 C.F.M.
Cook County Building	Chicago	13,000 C.F.M.
Majestic Building	Milwaukee	40,000 C.F.M.

The MULTI-PANEL, which cleans itself as it cleans the air, is the ideal filter for Air Cleaning Service. It assures a constant, uniform air supply with minimum attention and eliminates the human element as far as possible in the satisfactory performance of the air conditioning system of which it is a part.

THE AMERICAN AIR FILTER COMPANY introduced the MULTI-PANEL in 1928 and up to July 31, 1934, a six year period, there had been 803 installations sold consisting of more than 3,000 sections of various heights totaling 36,179,000 C.F.M.

AMERICAN MULTI-PANEL FILTERS, because of their dependability, efficiency and over-all economy are the choice of experienced engineers wherever a product proved by years of service is required.

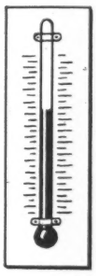
AMERICAN AIR FILTER COMPANY

Incorporated

107 Central Avenue, Louisville, Kentucky

In Canada, Darling Brothers, Limited, Montreal, P. Q.

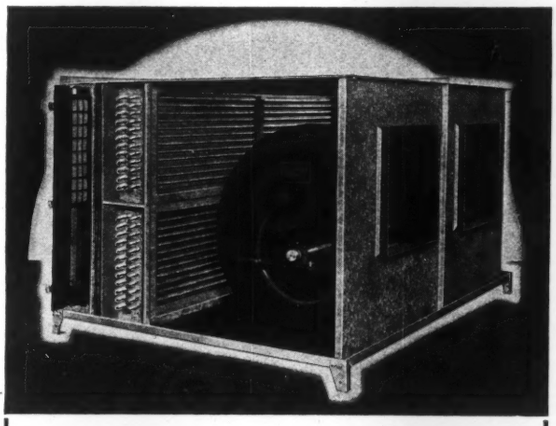
AMERICAN AIR FILTERS



Temperature!

Humidity!

Cleanliness!



FLASH! COMFORT CONDITIONER SALES STILL SOARING—

With hot weather well behind, Buffalo "PC" Comfort Conditioners are still being installed in increasing numbers. These flexible units are practical for many installations because they are available in combinations which provide everything from simple cooling or heating to complete year-round air conditioning.

You'll want a copy of Bulletin 2968 showing these and other units, if you are considering the installation of ventilating or air-conditioning equipment.

Write for it.

You've got to have all four to have air conditioning—and they must be "under control."

Because Buffalo has built air conditioning equipment since the beginning of the century, we admit that we know something about it. You'll want equipment with the engineering advantages arrived at in thirty-five years of successful manufacturing, so select Buffalo Air Washers, Fans, Unit Heaters, Unit Coolers and Comfort Conditioners.

Write for Bulletins.

Buffalo Forge Company

171 Mortimer St., Buffalo, N. Y.

In Canada: Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo" AIR CONDITIONING EQUIPMENT

SOUND AND DEPENDABLE PIPE

IS REQUIRED *for* COOLING COILS-

be sure to specify

NATIONAL PIPE FOR AMMONIA PURPOSES

In modern ventilating and air conditioning systems, the pipe used for cooling coils must be sound and dependable. NATIONAL PIPE FOR AMMONIA PURPOSES is increasingly preferred for such installations. It is a specially made, specially tested material that promises long, efficient, uninterrupted service. In the coiling and bending operations, loss of time, labor and material is reduced to a minimum; and when the installation is complete a sound, tight, workmanlike job is assured by the use of NATIONAL PIPE FOR AMMONIA PURPOSES. The skill, experience, facilities, and organization of the largest manufacturer of tubular products in the world are represented in this superior pipe. Approval of ice machine manufacturers, consulting engineers, and heating and ventilating specialists the country over has made it—

America's Preferred Pipe for Ammonia Purposes

NATIONAL TUBE COMPANY – Pittsburgh, Pa.

Pacific Coast Distributors—COLUMBIA STEEL COMPANY, San Francisco, Calif. *Export Distributors*—UNITED STATES STEEL PRODUCTS CO., New York, N. Y.

United States Steel Corporation Subsidiary

YOU MAY NEVER NEED IT

—But They Have It Just The Same

THE MORE-THAN-REQUIRED HORSEPOWER you get in every "Linc-Weld" motor is there for your protection... as a safeguard against failure... as a surety of long, carefree operation... as a guarantee of more dependable service for your money.

"Linc-Weld" gives you this extra capacity without sacrifice of power factor or efficiency. Every "Linc-Weld" feature contributes its share to make this possible.

"Linc-Weld's" arc welded frame is built of skyscraper construction—rolled steel for greatest strength and rigidity with least bulk.

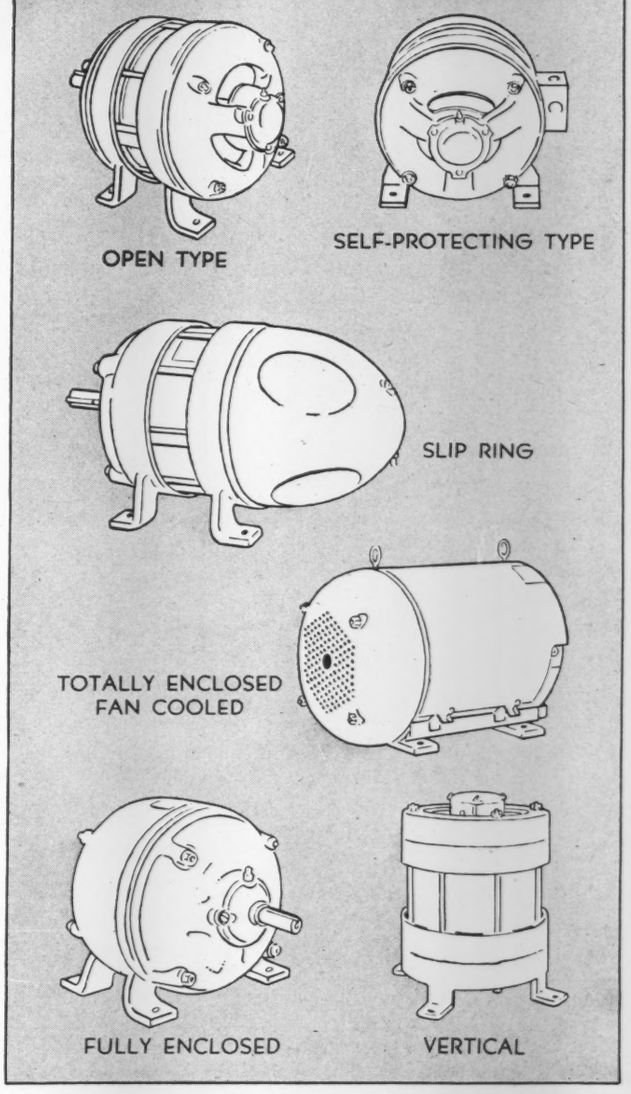
"Linc-Weld's" stator laminations are 28-gauge high silicon steel, heat treated.

"Linc-Weld's" waterproof insulation is permanently pliable—will never dry out or crack. It protects against attacks of dust, dirt and acid fumes.

"Linc-Weld's" rotor is statically and dynamically balanced.

"Linc-Weld's" performance proves the value of all these features.

We suggest if you want more for your money when you buy motors, that you find out about "Linc-Weld's" many advantages. Write THE LINCOLN ELECTRIC CO., Dept. RR-18, CLEVELAND, OHIO.



LINCOLN

"LINC-WELD" MOTORS

POP: "It isn't the size of the dog in the fight that counts—it's the size of the fight in the dog."

LAD: "Righto, Pop—and let that be a lesson to you. It isn't the electric motors in life that count—it's the life in the motors. 'Linc-Weld's' more-than-required horsepower assures us long dependable service for the money we spend on motors."

Burnham Big Twin

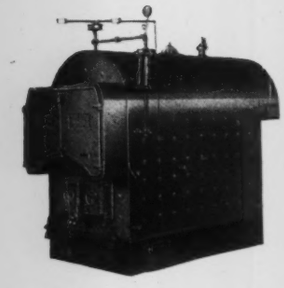
Cuts Out Tear Out Costs on Boiler Replacement Jobs

Leave the old boiler where it is. Or move it to one side and let it stay there. Then you can slip the sections of the Burnham Twin through any average door. No costly, time-taking tearing out necessary.

All sections except the front and rear ones are interchangeable. No rights and lefts. Can't go wrong in set up. Sections connected by short tie bolts. Header is built in the boiler.

Made in nine sizes to heat from 7,850 to 19,450 sq. ft. with coal, and 9,030 to 22,390 with oil.

Send for catalog. Get the facts. See for yourself.



P.S.
If you prefer a Welded Steel Boiler, we have it. Makes no difference which, just as long as you get the one best adapted to your ideas and needs.

Burnham Boiler Corporation
IRVINGTON, NEW YORK
Representatives in all Principal Cities of the United States and Canada

FITZGIBBONS
STEEL *HEATING* BOILERS

The R-Z-U

A favorite selection for the economical heating of churches, schools, office buildings and similar edifices.

One of a long line of steel heating boilers which for half a century has been building a reputation for eminently satisfactory heating service, with any fuel, in any heating system. Write us for details, specifying the conditions you wish to meet.

Fitzgibbons Boiler Co., Inc.

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Works: Oswego, N. Y.
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For Summer and Winter Air Conditioning Systems

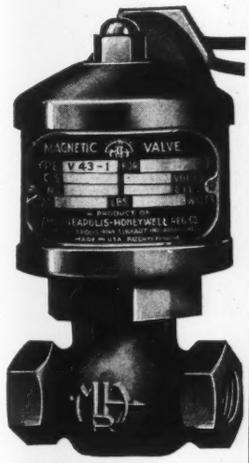
—use MONCRIEF AIR CONDITIONING PIPE AND FITTINGS

with special lock joints. Modern, accurately made, compact. Everything necessary to install a complete air conditioning system. Send for new catalog.

THE HENRY FURNACE & FOUNDRY CO.
3480 E. 49th St., Cleveland, Ohio

AIR CONDITIONING CONTROLS

for
Domestic or
Commercial
Installations



Magnetic Shutoff Valve. Silent Solenoid valve with replacement seat and plunger. Especially designed for domestic air washers

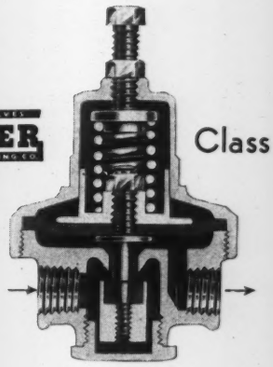
MINNEAPOLIS-HONEYWELL Air Conditioning Controls govern all phases of this work, including heating, cooling, ventilating, humidifying or dehumidifying. There are controls for every application, each designed to accomplish its particular function with characteristic Minneapolis-Honeywell accuracy and efficiency. Minneapolis-Honeywell Regulator Company, 2701 Fourth Avenue South, Minneapolis, Minn. Branch and distributing offices in all principal cities.

MINNEAPOLIS-HONEYWELL
Control Systems

The Place for **Y** Pressure Regulators

FOSTER

Class 34Y



Have you any pressure regulating problems on steam, liquids or gases where the volume is small—where initial pressures are variable and may run as high as 3000 pounds—where delivery pressures range from ounces to 250 pounds in a single stage reduction? Do you require extremely accurate regulation? If so, one of the several modifications of the Foster Class Y Pressure Regulators will meet your requirements. Sizes range from ½" to 2".

Bring your pressure regulating and any automatic control problems to our staff of experienced engineers for recommendations as to type, size and application.

FOSTER ENGINEERING CO.
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ADSCO ROTARY METER

Available in 7 sizes

250 to 12,000 lbs. per hr.

Meter the steam as condensate—from heating systems, water heaters, cooking equipment or other closed systems in which steam is condensed. Guaranteed for accuracy.
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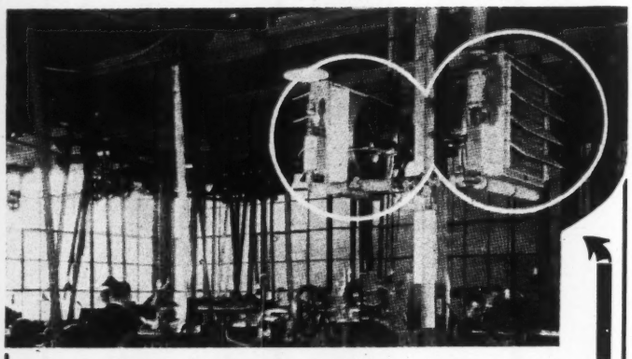
AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA N.Y.
OVER FIFTY YEARS IN BUSINESS



WOLVERINE UNIT HEATERS and coils have, in years of actual use, shown exceptional savings in fuel.
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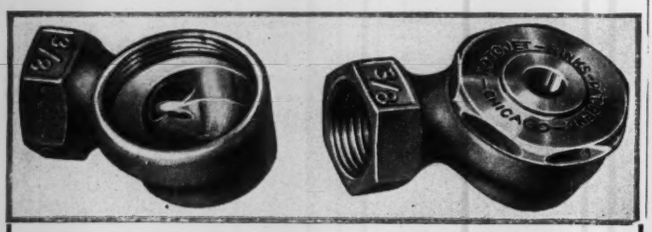
MYCO MANUFACTURING CO., 1120 Buhl Bldg., Detroit, Michigan



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ROTOJET Nozzles furnished in sizes from ¼" to 2½" pipe connections. Nozzle with cap removed shows involute whirl chamber. Binks ROTOJET Clog-Proof Spray Nozzles are the first choice of engineers everywhere for more efficient AIR WASHING. Send for Bulletin 50 today.

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ENGINEERED WELDING FITTINGS

Forged and formed seamless—all walls at least full pipe thickness and thicker at points of stress. Bright, clean, machine-tool bevel insures better and faster welding. All sizes, types, and styles in all pipe diameters and thicknesses. Prompt deliveries from stock.

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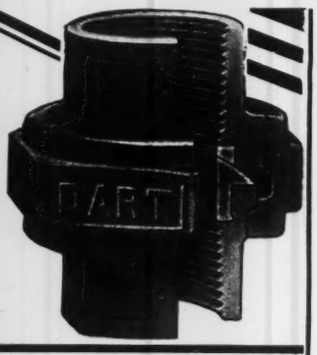
STRENGTH

Is built into each DART UNION . . . for every one must give years of efficient and trouble-free service. Bronze to Bronze ground joint seats which cannot corrode, malleable iron pipe ends and nut . . . Dart Unions insure leak-proof joints.



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Sales Agents: The Fairbanks Company, New York and at all branches. Canadian Factory: Dart Union Company, Ltd., Toronto

TITUSVILLE FIREBOX BOILERS

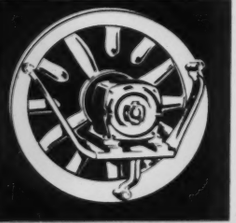
THERE'S ONE FOR EVERY HEATING JOB

HIGH EFFICIENCY LOW MAINTENANCE

Do the job *More Economically* with one of the Titusville Family of *Firebox Type Boilers* —the efficient solution to every heating problem. Write for Bulletin 9090-AHAC.

THE TITUSVILLE IRON WORKS COMPANY
Division of Struthers Wells-Titusville Corporation
TITUSVILLE, PA.

Fans



AIR SWIRL
at
Propeller Tips Eliminated

Greater capacity per fan diameter than other airplane fans.
Sizes—12" to 84."
Ask for Bulletins

INTERNATIONAL ENGINEERING, INC.
Dayton, Ohio
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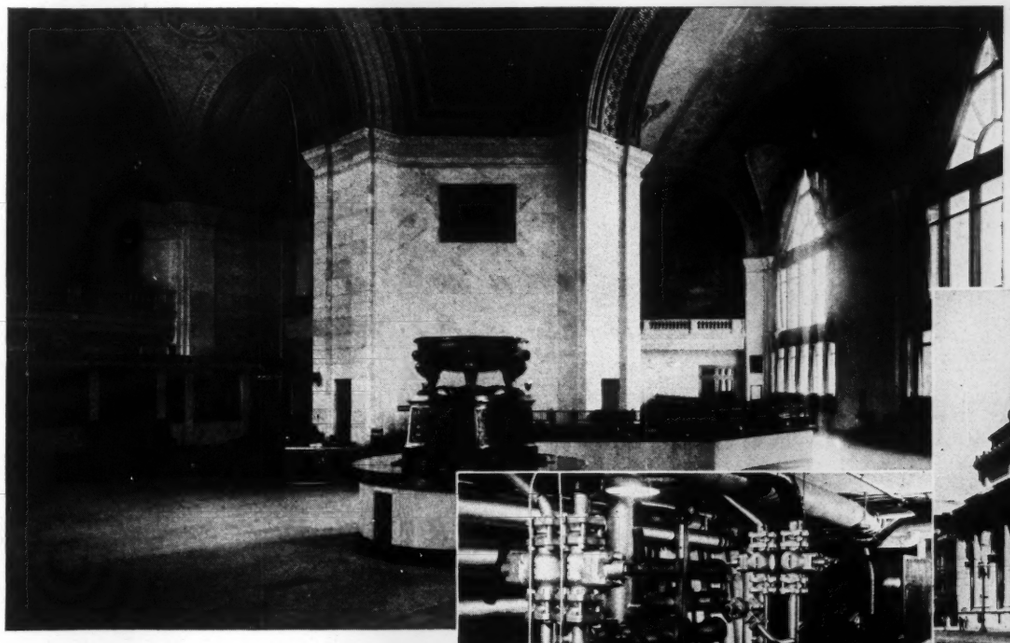
INTERNATIONAL

READING
GENUINE PUDDLED WROUGHT IRON PIPE

READING IRON COMPANY • PHILADELPHIA

Again...

CARBONDALE IS SELECTED



Architects:
Edward B. Green and Son, *Buffalo*

Consulting Engineers:
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90-ton installation includes two compressor, condenser and cooler units.

FOR AN IMPORTANT AIR CONDITIONING JOB

THIS 90-ton Carbondale CO_2 installation for the Buffalo Savings Bank represents a further recognition of the records established by Carbondale units for reliable performance in meeting exacting requirements.

CARBONDALE

CARBONDALE MACHINE CORPORATION
UNIT OF WORTHINGTON PUMP AND MACHINERY CORPORATION
General Offices: HARRISON, NEW JERSEY

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AR-3518

"Just Around the Corner"

AMERICA'S INDUSTRIES FIND CRANE STOCKS

● Crane service in valves, fittings, and piping is a *localized* service. Within 24 hours of every factory in the United States, and within one to two hours of a great majority of them, complete stocks of Crane valves and fittings are available.

The Crane line is extensive, capable of answering the daily requirements of the 209,348 industrial establishments within the service areas where Crane stocks are carried.

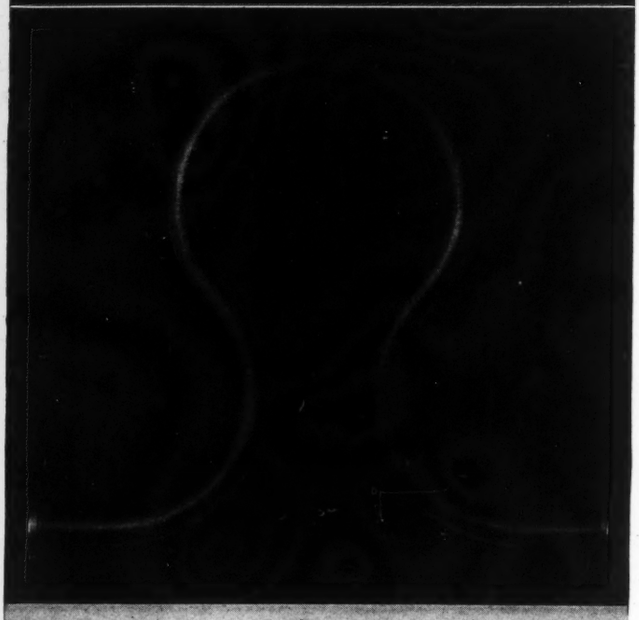
Crane materials will help you solve any piping problem. If extensive modernization is contemplated, the Crane Finance Plan allows you to spread the cost over a period of years.

CRANE SHOP FABRICATION SERVICE

Design — Flanging
Casting — Cutting
Bending — Threading
Welding — Assembling

There is a Crane Valve or Fitting for every piping requirement

INTEGRATED PIPING



Crane Expansion Pipe Bend

1 Just one item in the Crane line of complete pipe fabrication services.

2 Crane pipe bends will fit exactly into their place in your piping—specially built machinery assures this.

3 Connecting ends of bends may be threaded, beveled for welding, flanged and refaced or Cranelapped for Vanstone joint.

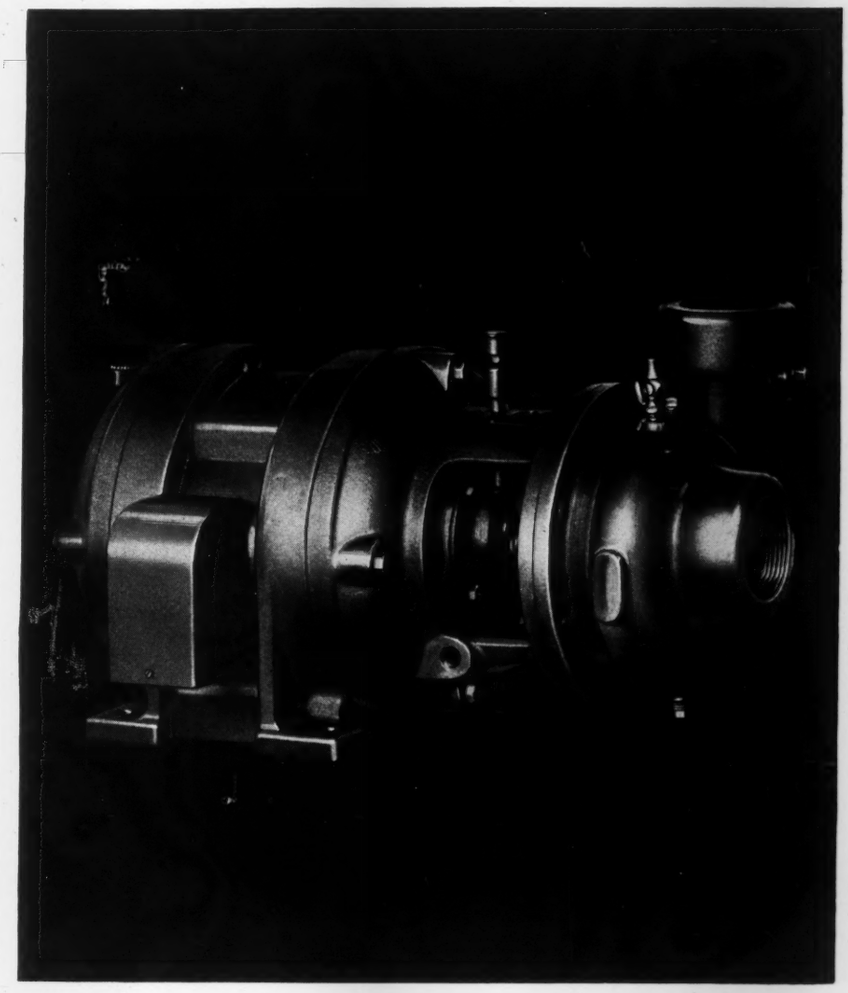
4 Crane eliminates wasteful and inconvenient divisions of responsibility by centering pipe fabrication in one organization with valve and fitting manufacture.

CRANE

CRANE CO., GENERAL OFFICES: 836 S. MICHIGAN AVE., CHICAGO, ILLINOIS • NEW YORK: 23 W. 44TH ST.

Branches and Sales Offices in One Hundred and Sixty Cities

CRANE VALVES, FITTINGS AND PIPE FABRICATION



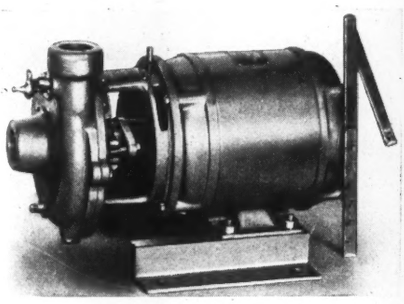
Suitable Centrifugal Pumps *for* Heating, Ventilating and Air Conditioning

SSU pumps are scarcely larger than the motors alone, and are low in cost, but they have high efficiencies comparable with any type of centrifugal pumps of similar size. They are compact enough to install on machinery and will handle from 30 to 800 gallons of liquid per minute. Some sizes will pump against heads up to 350 feet.

Both the pump and the motor are built by Allis-Chalmers. The pump impeller and motor rotor are mounted on a single shaft which is supported on two ample sized ball bearings. There can be no misalignment between pump and motor. Enclosed fan-cooled or explosion-proof motors can be furnished if desired.

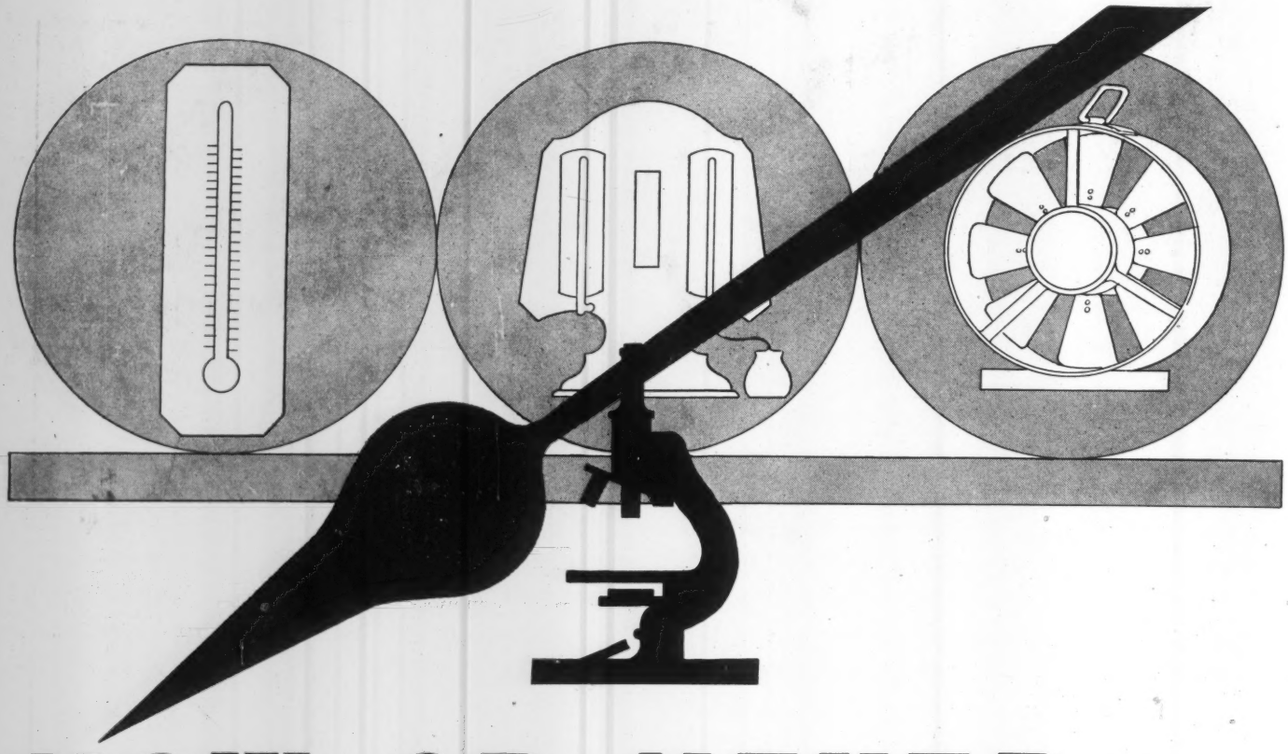
These small pumps are well adapted to air conditioning applications of various kinds, the extensive range of sizes available allowing the most suitable pump to be selected. SSU pumping units are also used for heating service. Where larger capacities are needed Allis-Chalmers standard Type S pumps will give efficient and reliable service.

1½" x 1¼" pump with ½ hp single phase motor



ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee



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